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ABSTRACT

The topics of tornadoes and hurricanes are important to children but are often missing from elementary textbooks. This document is a part of "The Natural Disaster Series" and is an attempt to supplement elementary science and social studies programs with lessons and student activities. Reasoning skills are emphasized throughout the booklet. Three questions follow each lesson's introductory information. These ask the student to: (1) think about cause and effect; (2) make a prediction based on the information in the selection; and (3) draw a conclusion which is supported by the evidence. These questions can be used by teachers for diagnosis, practice, or testing. Each of the 15 lessons also includes an instructional activity which is intended to reinforce the main idea of the lesson. The lessons and activities are not sequential and contain information and concepts that overlap into art, literature, history and safety. A glossary is included which is indexed to the page numbers where each term is used. (TW)

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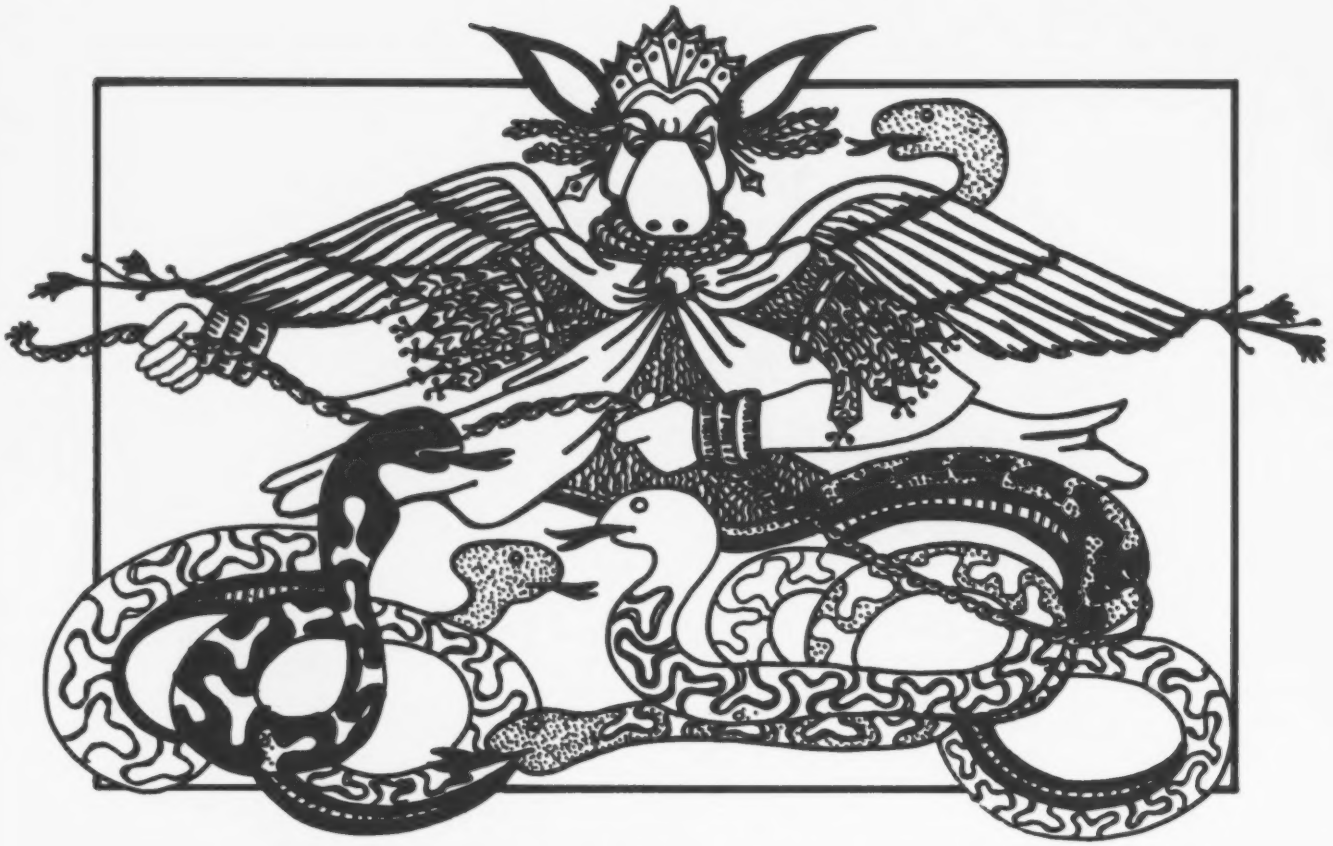
Tornadoes & Hurricanes

by

Ruth Deery

illustrated by Mary Micallef



Typhon, the Greek god who gave his name to the Pacific hurricane

Cover by Phil Brevick

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A WORD TO THE TEACHER

THIS BOOK STRESSES REASONING SKILLS WITH A STRONG EMPHASIS ON SCIENCE CONTENT.

The first of the three questions at the end of each selection asks the student to **think about cause and effect.**

The second question asks the student to **make a prediction** based on information in the selection.

The third question asks the student to **draw a conclusion** which is supported by evidence in the selection.

These questions are best used after the selection has been read and discussed and the activity on the back completed. The questions can be used as a basis for discussion or as tests to determine the students' reasoning abilities.

THIS BOOK DEALS WITH AN AREA OF SCIENCE AND SOCIAL STUDIES IMPORTANT TO CHILDREN, YET BARELY TOUCHED UPON IN ELEMENTARY TEXTBOOKS.

To many of our children, the prospect of a devastating hurricane or tornado is part of the structure of their lives. They need information about the forces at work, the responses of their own communities and government, and the effects upon other people in other times in order to make some sense of these threats. Such knowledge can help to move children's attitudes from fatalism towards confidence—an "I can cope" outlook.

LESSONS ARE NOT SEQUENTIAL.
IT'S O.K. TO PICK AND CHOOSE IN LINE WITH YOUR INTERESTS.
YOU'LL FIND SCIENCE, ART, LITERATURE, HISTORY AND SAFETY HERE.

A wealth of related material is available in any library. For books on hurricanes and tornadoes, look under the Dewey Decimal numbers 551.5 and 551.6. For safety information, write to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 and ask for current listings and prices of NOAA disaster preparedness publications. Some of the titles available at the time of this book's writing are listed on pages x and xi. One book you will want in your classroom for its magnificent photographs and diagrams is probably not in your school library because of its high reading level: the Time-Life book *Storm*, published in 1982. You will find it in your public library under the Dewey Decimal number 551.5.

W

My thanks go to my long-time collaborator, Harold Deery, whom I consider the world's best proofreader and consultant; to my new friend, Mrs. Liberato Garcia, for her help with the Spanish city names; and to the boys and girls in my classes who let me know without a moment's hesitation whether a teaching idea should be treasured or trashed.

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LESSON NOTES

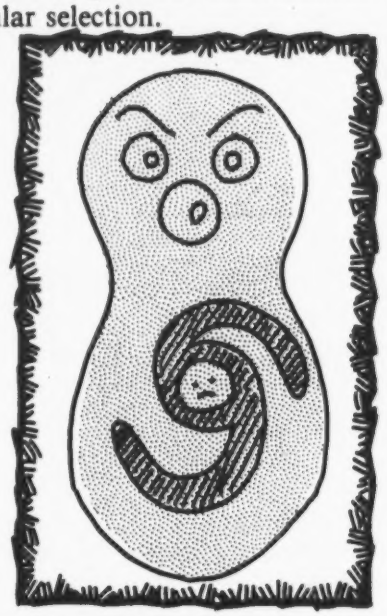
Lesson 1: WHY JOKE ABOUT IT?
A TORNADO STORY

Tall tales can be found under the Dewey Decimal numbers 808.8 (collections of literature) and 398.2 (folktales). *The Wizard of Oz* will be with fiction. Frank Baum is the author.

To get children excited about writing their tornado stories, invite those who already have ideas to share them with the class, or give the students three minutes (set your timer) to compare ideas with their neighbors before starting to write.

Point out to the students before they answer the thinking skills questions that sometimes more than one answer is true, but only one answer can be inferred from the article. In this story, for instance, all three endings to the third statement give true information. Only answer a, however, can be learned from this particular selection.

Lesson 1 answers: 1. c 2. a 3. a



Lesson 2: HURAKAN AND TYPHON
WORDS FROM THE NAMES OF THE GODS

Simulated stone soft enough to be carved with a Popsicle stick can be made from vermiculite and either casting plaster (plaster of Paris) or patching plaster. Some hardware stores stock plaster of Paris. Building supply stores stock patching plaster. Garden stores stock vermiculite.

If you crush the vermiculite fine, you can make a smooth surface which is easy to carve. Crush it in a heavy sack with a board or rolling pin. Mix equal parts of the crushed vermiculite and plaster. Slowly stir this mixture into water. The volume of water should be about a third the volume of the plaster and vermiculite mix. The mixture should be not quite dry enough to crumble. Drop by the half-cupful onto waxed paper to make oblongs. With fresh plaster, the mix will set in about half an hour. With patching plaster, leave it overnight. DO NOT rinse the excess down the drain; it will solidify in the pipes.

These oblongs can be carved into likenesses of the god Hurakan. The eyes, mouth, and spiraling arms can be darkened with pencil or ink. On the flat back of the carving, each student can incise "HURAKAN" as well as his or her own name. Salt-and-flour dough and papier-mâché will work too, but this simulated stone is closer to the original.

All but one of the word derivations on the back side of this lesson will be clear to most students. The exception is the word *lunatic*, which derives from Luna, Roman goddess of the moon. For many centuries it was believed that a person would "go crazy" (become insane) if he or she spent much time in moonlight. Hence the term *lunatic* denotes an insane person.

Lesson 2 answers: 1. b 2. a 3. a

Lesson 3: WHAT STARTS WINDS?
CURVING A STRAIGHT LINE

The idea that air takes up more space when heated is unfamiliar to many elementary school children. Point out to them that air is warmer near the ceiling; most of them have experienced this fact. The warm air rose because it was lighter than the colder, heavier air, which therefore settled near the floor and pushed up the lighter warm air. An easy demonstration with high interest will show that warm water rises. The idea that warm air rises then seems clearer by analogy.

You will need four identical jars such as quart mayonnaise jars, warm water, cold water, food coloring, two cards (such as 3 x 5 index cards), and a flat-bottomed dishpan. Prepare the demonstration while the children are out of the room, if possible.

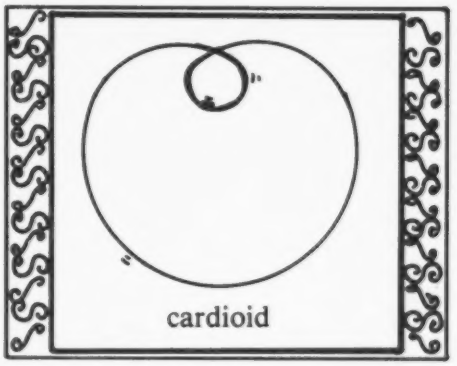
Fill two jars with cold water and two jars with warm water. Put food coloring in one of the jars of warm water and in one of the jars of cold water. Put both jars of colored water, one warm and one cold, in the dishpan. Using a card to prevent much spilling, invert the jar of uncolored cold water over the jar of colored warm water. Leave the card in. Similarly, invert the jar of uncolored warm water over the jar of colored cold water. Don't let the children feel the jars until after the demonstration is over.

Ask for two or three predictions as to what will happen when you pull the cards out. Then pull out the card between the pair of jars that have the cold, uncolored water on top. Hold the top jar in place with one hand as you pull out the card with the other. The colored water, being warmer, will rush up and mix with the uncolored water. In a short time the water in both jars will be of the same color.

Then ask for two or three more predictions as to what will happen when you pull out the other card. When you pull it out, nothing will happen at all; the water in the jars will not mix. After expressions of astonishment have subsided, let the children ask questions and make hypotheses for a few minutes before explaining the difference between the two setups. Draw the analogy that warm air rises just as warm water rises; that's why hot air balloons work and why smoke rises over a fire.

CARVING A STRAIGHT LINE makes an excellent learning center activity. After the students have turned in the required paper, they will want to continue to experiment. Let

them. Most children produce concentric circles of different colors. Gifted students sometimes learn to adjust the speed of the turntable and the speed of their pens to produce cardioids.

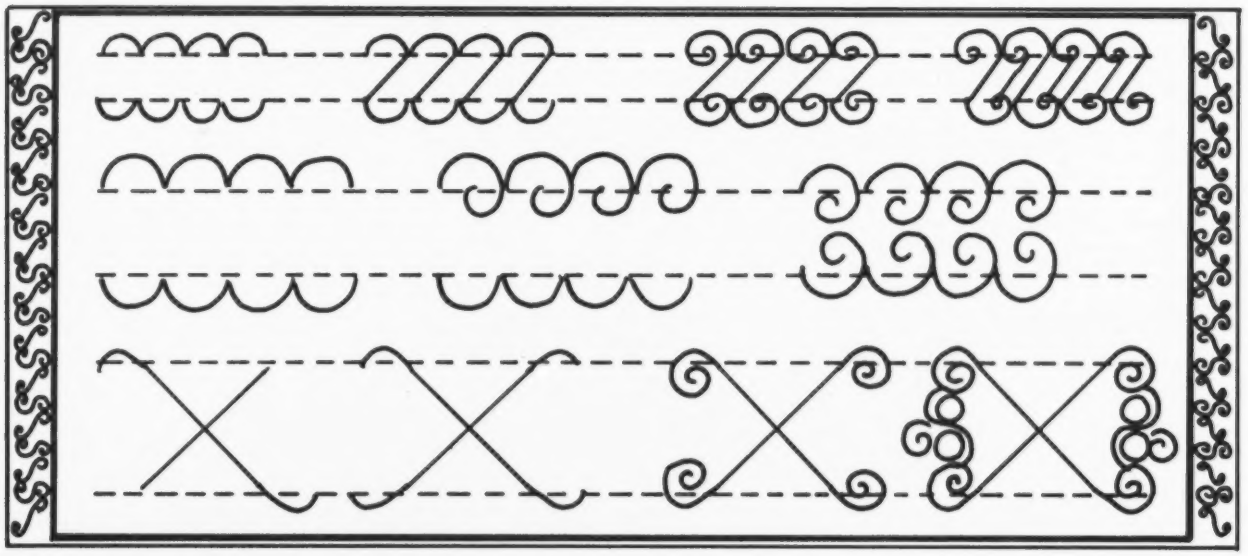


Lesson 3 answers: 1. c 2. b 3. b

Lesson 4: AIR WHIRLS AND WATER WHIRLS
WIND AND WATER IN EARLY ART

"Bathtub twisters" can be made to go clockwise in some containers but not in others, depending on the container's shape. A day or two after starting this lesson, ask your students which of them were able to make the twister continue to spin clockwise after they stopped stirring it.

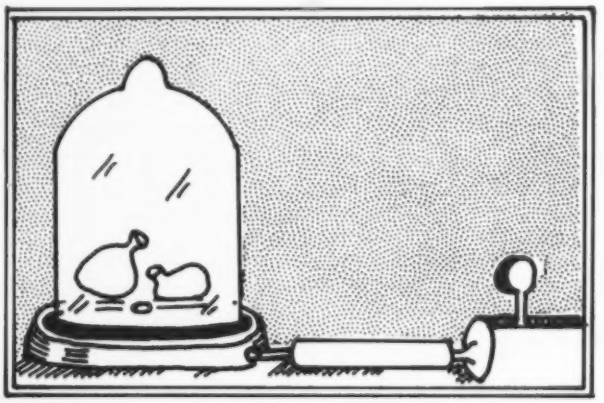
The work on the back side will be more effective if you first give a "follow-the-leader" art lesson. Paper with lines works best for this, but unlined paper will do. Use the overhead projector or the chalkboard to develop spiral and sigmoid designs such as the following. Leave each stage on the screen or board as you proceed to the next. Don't get more than one stage ahead of the children. At the end of the lesson your screen or board should look something like this:



Lesson 4 answers: 1. b 2. a 3. a

Lesson 5: LOW, LOW PRESSURE
LOW PRESSURE AND TORNADO FREAKS

If you can find a bell jar and a vacuum pump, you can give a demonstration which will clarify the idea of low air pressure for your students. Perhaps your school has a bell jar with its science equipment. If not, you can probably borrow one from a high school or college physics department.



The easiest and most enlightening demonstration is the enlarging of a small balloon as air is pumped out of the jar. For a really spectacular demonstration, put several small balloons of different colors in the bell jar. You can also pop the cork out of a bottle. DO NOT try to open a sealed bottle of pop; you might break the bottle instead and the flying glass might damage the bell jar (to say nothing of your composure). With older children or a gifted class you might want also to put in the jar a cup of warm water and lower the pressure until it boils. You will want to point out, if you do this demonstration, that the lower air pressure with the increasing altitude means that water boiling on a mountaintop will not be as hot as water boiling at sea level. Therefore, it takes longer to boil eggs and cook vegetables on a mountain.

TORNADO FREAKS. The activity on the back side of this lesson is intended as a discussion starter. After giving the students time to talk over their ideas with their neighbors, or groups, call them together to share their answers and compare them with those in the "cheat book." Give the students the chance to change their answers if others seem more convincing.

BICYCLE TIRES and RUBBER RAFTS would probably burst.

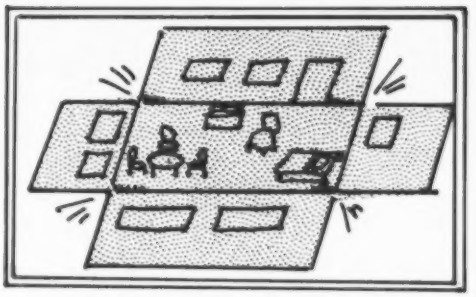
WATERPROOF WATCHES (which, of course, means airtight watches) might break their crystals.

CORKED BOTTLES would blow their corks, and the liquid in full ones might start to boil or be sucked out.

FREEZERS would probably blow open, and SAFES might also.

EARS would hurt because of bulging eardrums. Sounds would be muffled because of the larger space in the inner ear. We experience the same effect on a smaller scale when riding in a fast elevator or an open plane, or climbing a mountain. By yawning or swallowing, we open the Eustachian tube so that the pressure can equalize and sounds return to normal. In an extreme case, of course, eardrums might break.

The air in TIGHTLY CLOSED HOUSES exerts a force of several thousand tons on the walls. Normally the air on the outside exerts an equal pressure and the walls stay in place. When air pressure outside falls suddenly. Walls have been known to fall down flat on all sides and the roof sail away in the wind.



OPEN HOUSES might remain intact but blankets, rugs, furniture, and clothes might sail out through doors and windows as the inside air blew out. For many years before the low pressure aspect of tornadoes was understood, many people wondered why churches were often damaged by tornadoes and taverns usually were not. Now we know that the taverns escaped because they were open much of the time, whereas churches are usually open only on Sunday morning.

Lesson 5 answers: 1. a 2. b 3. b

Lesson 6: TORNADO ALLEY
WATCH A TORNADO FORM

WATCH A TORNADO FORM. If your students have not made flip books before, a few cautions will make this activity go more smoothly. Ask if they have seen books with cartoon characters on the upper corners of the pages. When you flip the pages of the book, the characters seem to move. A flip book works the same way. Tell them that the straighter they cut the pictures along the top, the better the flip book will work. Be sure they understand that each number is to stay attached to the picture above it. Have a few extra sheets available for those who make the mistake of cutting the numbers off despite your warning.

If your students do not live in tornado country, you may want to have in the classroom a few books with pictures of tornadoes so that the children will realize that tornado funnels have many shapes, and sometimes come in groups. You will find pictures of tornadoes in many of the books on storms (Dewey Decimal 551.5 and 551.6). *Storm*, published in 1982 by Time-Life Books, and *Storms and Man* by Frank Ross, Jr., published in 1971 by Lothrop, Lee, and Shepard Co., have particularly impressive pictures of tornadoes.

Lesson 6 answers: 1. c 2. b 3. b

Lesson 7: HIGH, HIGH WINDS
A TOOTHPICK AND NERDLE DOLL

A TOOTHPICK AND NERDLE DOLL makes a good interest center activity; it also works as a whole-class activity. If you go in for scrapcraft art, the doll can be part of an art lesson in which you use found objects such as milk cartons, spools, corrugated paper, and cloth scraps to create dwellings for the dolls (dwellings which can also be subjected to lung-strength winds).

Lesson 7 answers: 1. b 2. a 3. b

Lesson 8: NAMING HURRICANES
1987 HURRICANE NAMES

Books about hurricanes can be dated with fair accuracy by what they say about the naming of hurricanes. Several naming systems have been tried. The one described in this lesson has been in effect only since 1979. NOAA distributes a sheet containing the six-year lists of names for both Atlantic storms and eastern Pacific storms, together with a brief history of the naming of hurricanes. For a copy, write to the U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Rockville, MD 20852. Ask for publication NOAA/PA 79017, "The Naming of Hurricanes."

Lesson 8 answers: 1. b 2. a 3. c

Lesson 9: HURRICANE HUNTERS
WHAT'S INSIDE A HURRICANE?

Some of your students may be World War II buffs. If so, they may be interested in the details of the first flight into a hurricane. Look in the indexes of books in your library with the Dewey Decimal number 551.5 and 551.6 for references to Duckworth, Major Joseph P. Two good write-ups are in Thomas Helm's *Hurricanes: Weather at Its Worst*, New York, Dodd, Mead, and Co., 1967 and Brown and Brown's *Historical Catastrophes: Hurricanes and Tornadoes*, Reading, MA, Addison Wesley, 1972.

A typhoon set back the U.S. Third Fleet in World War II. Descriptions of that event can also be found by consulting indexes of books with the Dewey Decimal numbers 551.5 and 551.6. Look under Halsey, Admiral. One good write-up on this is the same Thomas Helm book mentioned above. Another is in Frank Ross, Jr.'s *Storms and Man*, New York, Lothrop, Lee, & Shepard Co., 1971.

WHAT'S INSIDE A HURRICANE? For excellent diagrams of hurricane structure based on recent research, consult the 1982 Time-Life book *Storm*, Dewey Decimal number 551.5.

Lesson 9 answers: 1. c 2. b 3. c

Lesson 10: TORNADO CHASERS
MY TORNADO ACTION PLAN

All children need to know what to do in case of a tornado because, unlike hurricanes, tornadoes occur in all states. Where tornadoes are rare, schools conduct no tornado drills, and the media treat tornadoes as distant events; hence, panic behavior raises the death toll when a tornado does occur. Class discussion should therefore both precede and follow the filling out of the Tornado Action Plan.

You or your students may want to send for some or all of these publications of NOAA:

NOAA/PA 75012	*Owlie Skywarn's Tornado Warning*, a 16-page booklet written for use at about fifth grade level. It describes tornadoes and safety rules.
NOAA/PA 82001	*Tornado Safety: Surviving Nature's Most Violent Storms*, an 8-page booklet describing tornadoes, explaining the National Weather Service Watch and Warning program, and suggesting individual and community preparedness measures. Graphs and maps fit fifth grade math and social studies.
NOAA/PA 76016	"Tips for Tornado Safety," a wallet card.
NOAA/PA 75015	"Tornado: Do You Know What to Do?" an 8½" x 11" cardstock poster with spaces to fill in the local signals and individual plan.
NOAA/PA 76019	"Skywarn: Seconds Save Lives!" an 8½" x 11" poster with brief directions about what to do in case of a tornado warning. It is intended for posting in schools and other public places.

All these publications are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Ask for current prices.

Lesson 10 answers: 1. c 2. b 3. a

Lesson 11: DEFENDING OURSELVES AGAINST HURRICANES
MY HURRICANE ACTION PLAN

The activity sheet with this lesson deals only with personal hurricane plans. Community planning is equally important. Both types of planning are addressed in NOAA publications available at a nominal cost from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. Ask for current prices.

NOAA/PA 77001 — *Owlie Skywarn's Hurricane Warning*, a 16-page booklet written for use at about fifth grade level. It describes hurricanes and safety rules.

NOAA/PA 76009 — *When a Hurricane Threatens*, a 16-page booklet describing hurricane storm surge, wind, and flooding with an action checklist for each.

NOAA/PA 78019 — *Storm Surge and Hurricane Safety with North Atlantic Tracking Chart*, an 8-panel folder. Four of the panels condense the information in the booklet above; three panels have a large tracking chart for North Atlantic hurricanes.

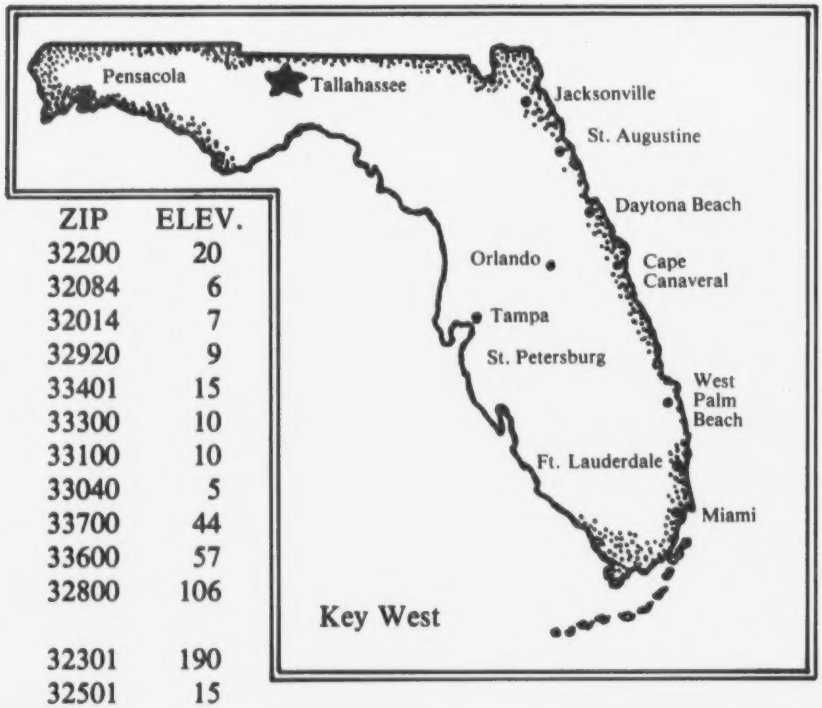
NOAA/PA 70027 — "Survival in a Hurricane," a 4-panel wallet card.

NOAA/PA 70028 — *The Homeport Story*, a 24-page book about an imaginary town named Homeport. See paragraphs below for its usefulness in a student project.

NOAA/PA 75003 — *Hurricanes, Florida and You*, a 16-panel folder with hurricane history and safety rules of particular interest to residents of coastal Florida. See paragraphs below for its usefulness in a student project.

The NOAA recommends that all communities on the Atlantic and Gulf coasts make plans for action in case of a hurricane threat. To help communities that have not already done this, NOAA's National Weather Service has invented an imaginary town named Homeport as a model of hurricane preparedness. If you live in hurricane country, comparison of your community's hurricane plans with those in Homeport would make an excellent student project.

If you do not live in hurricane country, you may want to have your student write to chambers of commerce in cities within the hurricane-prone area asking for descriptions of their community action plans for hurricanes. On the following page are elevations in feet above sea level and the zip codes of a few cities in Florida; the entire state of Florida is at risk from hurricanes. Comparing the plans of any two of the communities, or of any community with the model HOMEPORT plan, would make fine individual projects for your more gifted students. For students choosing a coastal community, the publication *Hurricanes, Florida and You* would be valuable.



CITY	ZIP	ELEV.
Jacksonville	32200	20
St. Augustine	32084	6
Daytona Beach	32014	7
Cape Canaveral	32920	9
West Palm Beach	33401	15
Ft. Lauderdale	33300	10
Miami	33100	10
Key West	33040	5
St. Petersburg	33700	44
Tampa	33600	57
Orlando (Disney World)	32800	106
Tallahassee	32301	190
Pensacola	32501	15

Lesson 11 answers: 1. b 2. b 3. a

Lesson 12: WEATHER SATELLITES: SPIES IN THE SKIES
PUT WEATHER SATELLITES AROUND YOUR CLASSROOM GLOBE

GOES is an acronym for Geostationary Operational Environmental Satellite. TIROS-N is an acronym for Television and InfraRed Observation Satellite, New (the old one went up in 1960). You might point out to your students that each has only a few more syllables than Supercalisfragilisticexpialidocious, which they can already reel off.

Elementary students find it difficult to understand that a satellite which remains at the same spot over the earth is really orbiting. Satellite dishes don't appear to move; how can the object at which they are aimed be moving? To clarify this concept, have one student slowly turn the classroom globe while another keeps a bead on a string, or a satellite model if one has been made, suspended over the same spot on the equator. The satellite is clearly moving.

Reproductions of satellite pictures are available for the cost of reproduction and handling. For current prices write or call NOAA/Satellite Data, Services Division, Room 100, World Weather Building, Washington, D.C. 20233. Telephone: 301-763-8111.

PUT WEATHER SATELLITES AROUND YOUR CLASSROOM GLOBE. Making satellite models is a good interest-center activity. It will appeal particularly to your more manually gifted students. Any number of satellites can be correctly hung over one globe. This structure makes a good display for the case in the front hall, where the problem of suspending large numbers of objects from the ceiling is usually less acute than in most classrooms.

Lesson 12 answers: 1. a 2. a 3. b

Lesson 13: WHAT ABOUT COLUMBUS?
A HURRICANE'S PATH

You may wish to choose a hurricane other than David of 1979 as the one whose wind-battered cities your students are to list. A 16-page NOAA publication shows the paths of the worst hurricanes of the century up through 1980. Titled *Some Devastating North Atlantic Hurricanes of the 20th Century*, it is for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Ask for Department of Commerce publication NOAA/PS 77019. Prices are subject to change without notice; ask for the current price.

Lesson 13 answers: 1. a 2. b 3. c

Lesson 14: TREASURE SHIPS
WHO OWNS THE TREASURE?

Large-scale piracy followed large-scale shipping of treasure. Hurricane-damaged ships were easy prey, and when they sank in shallow water, pirates often beat the ships' owners to the spot. Thus, study of piracy is related to study of hurricanes.

If your students are not already familiar with Robert Louis Stevensons' *Treasure Island*, this would be a good time to introduce them to it. Although basically fiction, the story includes as characters several actual pirates of the time. One edition of *Treasure Island* includes an entertaining six-page essay on pirates and pirate treasure. It also features a map showing the location of several actual sunken treasure ships. It has marginal illustrations which make the archaic terms in the story understandable. Look for the version illustrated by Don Irwin, published by Children's Press, Chicago, 1968.

WHO OWNS THE TREASURE? Before undertaking this decision-making simulation, your students need to know at least a little about the problems and expense of diving for treasure. One source is Robert Marx' book *The Lure of Sunken Treasure*, New York, David McKay Co., 1973, written at approximately sixth grade reading level. This book recounts, among other things, the recovery of treasure from a Spanish treasure fleet and the discovery of two of Columbus' ships which he abandoned in the New World on his ill-fated fourth voyage. The Dewey Decimal number is 910.453.
M

As with all simulations, it is important that the process and outcome of the simulation be evaluated with the class. Did everyone have a part in the discussion? Did students really compare the ideas before voting? Was a consensus reached, or did a majority decide? What should be done differently next time?

Lesson 14 answers: 1. c 2. a 3. a

Lesson 15: HURRICANES AND HISTORY: THE SPANISH ARMADA
WHAT IF SPANIARDS HAD NAMED THESE CITIES?

This lesson is for students in fifth grade and above. Few fourth graders know the location of Spain and England or, for that matter, New England, unless they happen to live there. As with space, so with time; dates mean nothing to many of them.

WHAT IF SPANIARDS HAD NAMED THESE CITIES? Noun gender can be a stumbling block to English-speaking children accustomed only to neuter nouns. Before assigning this sheet, explain the masculine and feminine endings on the adjectives. In Aguaclara (Clearwater), *agua* (water) is a feminine noun; therefore *clara* (clear) has a feminine ending. In Ciudad Lago Salado (Salt Lake City), *lago* (lake) is masculine; therefore *salado* (salty) has a masculine ending.

Your students may prefer to rename in Spanish the cities in their own state or region. This is great fun, and with the aid of a Spanish-speaking student or friend it can also be correct. A Spanish dictionary is a help. Cassell's is standard. It can be found under the Dewey Decimal number 463.

C 272

Aguaclara	Clearwater	Florida
Campo del Fontana	Springfield	Ill., Mass.
Cascada Internacional	International Falls	Minnesota
Ciudad Atlantica	Atlantic City	New Jersey
Ciudad Bahaia	Bay City	Michigan
Ciudad Lago Salado	Salt Lake City	Utah
Curva del Sur	South Bend	Indiana
Independencia	Independence	Missouri
Lago Carlos	Lake Charles	Louisiana
Pedernal	Flint	Michigan
Playa Palmera de Occidente	West Palm Beach	Florida
Portatierra	Portland	Maine, Oregon
Providencia	Providence	Rhode Island
Roca Parva	Little Rock	Arkansas
San Paulo	Saint Paul	Minnesota
Selvaverde	Greenwood	Mississippi
Termas	Hot Springs	South Dakota

The above are all English names. If you live in a city with a French name, you and your students may be interested in the Spanish equivalents of the French meaning. For instance:

Baton Rouge	Red Stick	Estaca Colorada
Beaumont	Beautiful Mountain	Sierrabella
Bellevue	Beautiful View	Bellavista
La Crosse	The Stick	El Palo
Terre Haute	High Land	Tierra Alta

Lesson 15 answers: 1. c 2. a 3. a

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LESSON 1 Name _____

WHY JOKE ABOUT IT?

In Nebraska a tornado picked up some wagon ruts and dropped them in a spot where folks needed a road.

In Oklahoma some farmhouses have crowbar holes in them. When the wind is blowing and you want to know if it's safe to go out, you put a crowbar through the hole. If it only bends, it's still safe. If it breaks, you'd better stay indoors.

Are these stories tall tales? Of course they are. People often tell jokes and make up tall tales about things that worry them. When they can laugh, then they're not quite so scared.

When a tornado came roaring towards his cattle camp, Pecos Bill decided he had to break it the way he would break a wild horse. He held his bowie knife in his teeth and a twenty-dollar gold piece in one hand so he could get back to camp no matter where he landed. Then he leaped onto the tornado funnel. It jumped and bucked, but it soon found it couldn't throw Pecos Bill. This made it so mad that it began pulling up rocks and throwing them at Pecos. This kept him busy dodging, and by the time the tornado saw that it couldn't scare Pecos that way it had dug the Grand Canyon. Then the tornado got smart. It decided to rain out from under him. Pecos Bill saw that he soon wouldn't have any tornado to ride on, so he jumped. He landed so hard in the sand that it made a big hole in the desert. We call that hole Death Valley. Pecos Bill had ridden that tornado a long way from his cattle camp. When he took out the knife and the twenty-dollar gold piece, he found that the tornado had blown his bowie knife into a little pearl-handled jackknife and his twenty-dollar gold piece into two half dollars and a wooden nickel, so it took him longer than he had figured on to get back to camp.

1. According to the story, Pecos Bill rode a tornado because
   a. he wanted to rustle cattle.
   b. he wanted to show off.
   c. he wanted to steer it away from his cattle camp.

2. When something worries people, they may try to make themselves feel better by
   a. making jokes about it.
   b. riding a tornado.
   c. testing the wind with a crowbar.

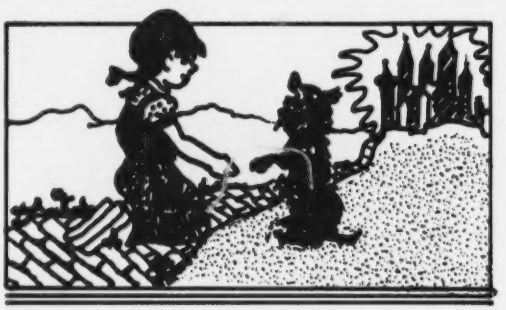
3. You can tell from the article that
   a. tornadoes can do a lot of damage.
   b. tornadoes sometimes come with thunderstorms.
   c. some places have more tornadoes than other places.

Name _____

A TORNADO STORY

Tornadoes are the most violent storms in the world. They have killed a lot of people and destroyed a lot of property. Sometimes, though, they do very gentle things. One tornado picked up a china cabinet and set it down hundreds of meters away without breaking a dish. Another picked up a lighted kerosene lantern and set it down four hundred feet away, unbroken and still lighted. A pond was picked up by yet another tornado and dumped on a town several miles away complete with the frogs that were living in it.

Some people have been picked up by a tornado and lived to tell about it. One man and his wife were sitting in their living room when a tornado threw them to the floor, picked up the house, pulled it to pieces around them, and then set the floor gently back on the ground without hurting the people at all.

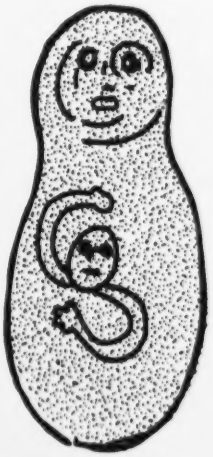


Tornadoes have done many strange things. Writers have used tornadoes in stories to do even stranger things. *The Wizard of Oz* starts with a tornado which carries Dorothy and her little dog Toto to the land of Oz.

What other strange thing might a tornado do—either really, like raining frogs on a town, or in imagination, like carrying Dorothy and Toto to the land of Oz? Write a story about it. Remember to give your story a title, to indent the first line, and to be careful with capitals, punctuation, and spelling.

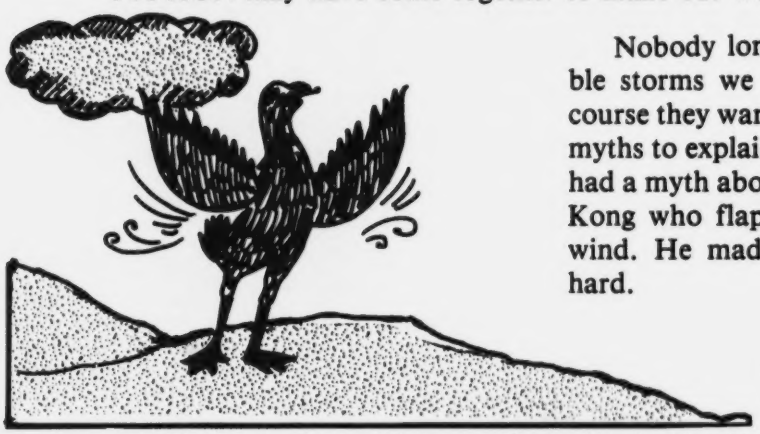
LESSON 2 Name _____

HURAKAN AND TYPHON



Long ago, long before whites came to this country, the Taino people lived in Cuba. Like other early people, they had gods for the sun, the wind, the rain, and many other things. The Taino lived where terrible ocean storms came every year. They had a special god for these storms. The name of this god was HURAKAN. The Taino made little stone images, each with a face on top and another face with spiraling arms on the stomach. Maybe they made these images to try to get magic power to keep Hurakan away. Our word HURRICANE comes from the name of the god HURAKAN. We use the word HURRICANE for this kind of storm in the Atlantic Ocean.

Storms like this in the Pacific Ocean are called TYPHOONS. The Chinese words TY FUNG mean Great Wind. The ancient Greeks believed in a huge monster named TYPHON, hundreds of miles high and wide, with wings that blocked out the sky and many coiled, writhing snakes for legs. Traders carried the word TYPHON with them and perhaps they used it to describe the terrible storms in the China Sea. TY FUNG and TYPHON may have come together to make our word TYPHOON.



Nobody long ago knew what caused the terrible storms we call hurricanes and typhoons. Of course they wanted to understand, so they made up myths to explain it to each other. People in Taiwan had a myth about a huge birdlike god named Hung Kong who flapped his monstrous wings to make wind. He made typhoons by flapping them too hard.

Today we don't blame the gods or make stone images to protect ourselves from hurricanes.

Still, the stories and images of people who lived long ago help us understand our own thinking.

1. People in Taiwan used to believe that the winds of a typhoon were caused by
   a. an angry god blowing upon the earth.
   b. a huge bird-god flapping its wings.
   c. air currents moved by the sun.

2. The Taino probably made stone images to
   a. try to protect themselves from hurricanes.
   b. practice stone carving.
   c. give to their children for dolls.

3. You can tell from this article that
   a. some of our words come from other languages
   b. typhoons are caused by a great bird flapping it wings.
   c. people can protect themselves from hurricanes with stone images.

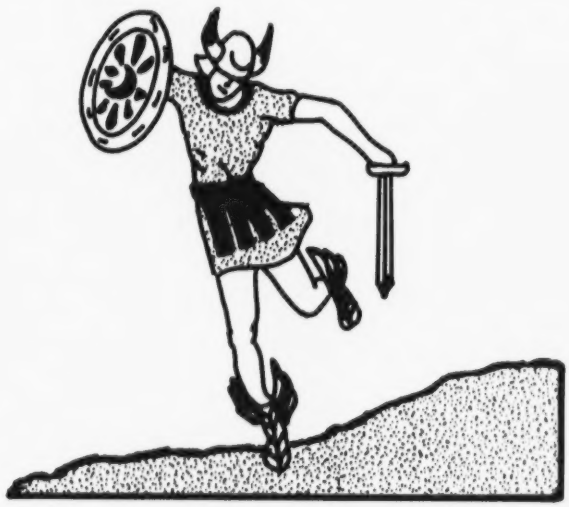
Name _____

WORDS FROM THE NAMES OF THE GODS

HURRICANE and TYPHOON are words that probably came from the names of gods. There are many more. See if you can match up the English word with the name of the Greek or Roman god that the word came from. Write the word from the word bank in front of the god or hero whose name is related to it. Are there any that don't seem to you to make sense?

WORD BANK

volcano	hypnotism
herky	solar
January	lunatic
morphine	martial
mortal wound	hygiene
cereal	terrace



_____ Janus: Roman god of beginnings and endings

_____ Hygeia: Greek goddess of health

_____ Vulcan: Roman god of fire

_____ Mars: Roman god of war

_____ Ceres: Greek goddess of the harvest

_____ Morta: Roman goddess of death

_____ Morpheus: Roman god of dreams

_____ Hypnos: Greek god of sleep

_____ Luna: Roman god of the moon

_____ Sol: Roman god of the sun

_____ Terra: Roman goddess of the earth

_____ Hercules: Greek hero famous for his strength

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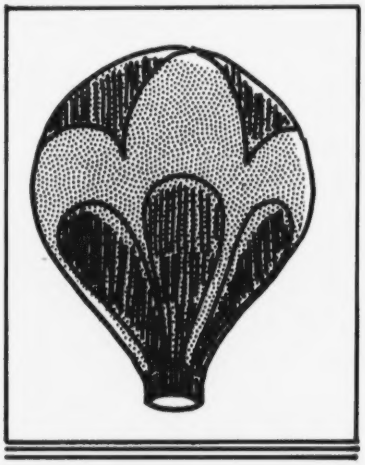
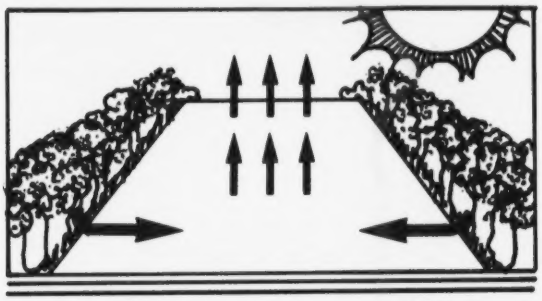
LESSON 3 Name _____

WHAT STARTS WINDS?

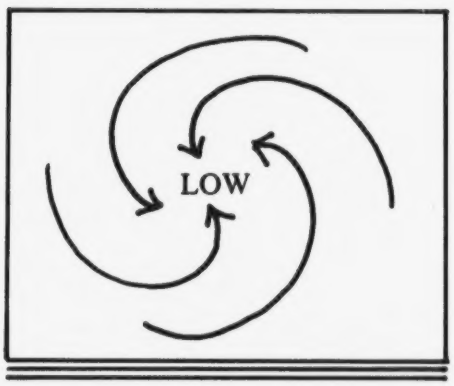


Hot air balloons rise because air, when heated, gets bigger without getting heavier. Colder, heavier air around it pushes the warm air up (and the balloon with it). Air over a fire in a fireplace gets hotter than the air in the room, so it gets bigger, so it gets lighter, so it gets pushed up the chimney, carrying smoke with it. When sunshine heats the ground, the air touching the ground gets hotter, so it gets bigger, so it gets lighter, so it rises. Scientists call these places where air is rising LOW PRESSURE AREAS, or LOWS. They call the places where air is sinking HIGH PRESSURE AREAS, or HIGHS.



If a small area like a field is heated, the rising air may bring in pleasant breezes from cooler places nearby. If a large area like a desert is heated, the rising air may bring in a dust storm. Over warm areas in the ocean, it may start a hurricane.

Wind doesn't blow in straight lines. When air blows from a HIGH towards a LOW, it always curves. North of the equator it curves counterclockwise around the LOW. South of the equator it curves clockwise. This is because the earth is spinning. The man who first described the way the earth's spin forces the wind to curve was named CORIOLIS, so this force is called the CORIOLIS FORCE.



1. It is hotter near the ceiling than near the floor in most rooms. This is because
   a. people walking around stir up the air near the floor and make breezes which cool the room near the floor.
   b. windows don't go clear to the ceiling.
   c. warmer air is lighter than cooler air, so it rises.

2. On a sunny day at the beach, the sand is hotter than the water, so the breeze will probably blow
   a. from the beach to the water.
   b. from the water to the beach.
   c. along the shore.

3. You can tell from the article that
   a. riding in hot air balloons is fun.
   b. the direction the earth turns affects which way the wind blows.
   c. smoke rises because it's lighter than air.

Name _____

CURVING A STRAIGHT LINE

You will need a record player, a circle of cardboard the size of the turntable, a circle of paper the same size as the cardboard, and felt pens in three colors. The cardboard is to keep the felt pen from coming through onto the turntable.

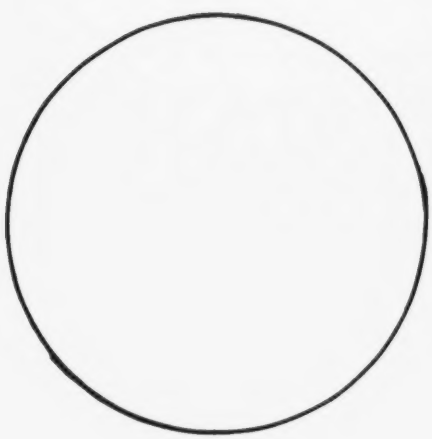
Put the cardboard and the paper on the turntable like a record. Turn the player on high speed.

Starting at the center of your paper "record," try to draw a straight line to the edge with one of the felt pens. Show what your line looks like on the first circle below.

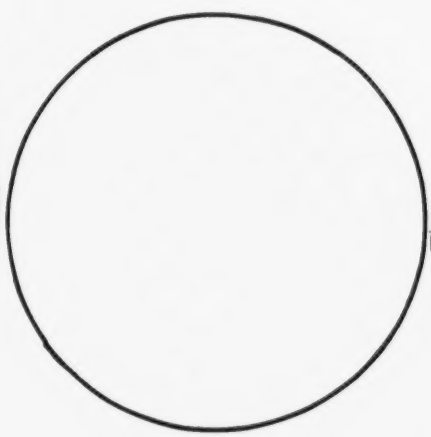
Choose a second color of felt pen. Try to draw a straight line to the middle of the paper circle starting at the edge. Show this on the second circle.

Using a third color, try to draw a straight line across the spinning paper, from one edge to the other. Show what your line looks like on the third circle.

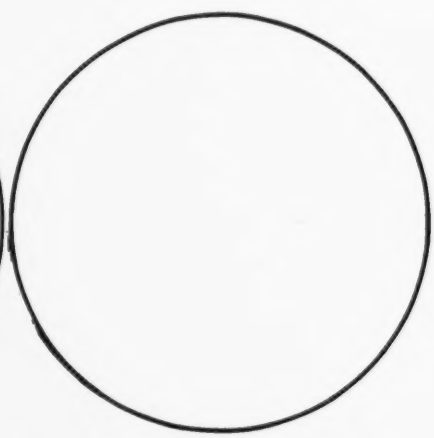
Your lines will probably not look like anyone else's lines. This is because some students drew their lines faster than others. Perhaps you will experiment with different record-player speeds and different drawing speeds.



My line from center to edge



My line from edge to center



My line from edge to edge

The wind trying to blow straight across the spinning earth makes a curve. This is like you trying to draw a straight line on a spinning turntable.

LESSON 4 Name _____

AIR WHIRLS AND WATER WHIRLS

Air and water hardly ever travel in straight lines. When you open the bathtub drain the water doesn't just flow out. It whirls out. A river current doesn't flow straight. It makes eddies and whirlpools. If you put a paper boat in a gutter full of water, the boat will turn in the current. A flag doesn't fly straight because the air eddy around it pulls it first to one side and then the other. On a hot, dry day you can watch little whirlwinds in your driveway make "dust devils," blowing dust and leaves around and around.

Next time you empty the bathtub or washbasin, notice which way the twister turns. Most of the time it turns counterclockwise. Can you make it go clockwise instead? If you lived south of the equator, it would usually turn clockwise. The turning of the earth starts the spin going clockwise south of the equator and counterclockwise north of it.

Hurricane and typhoon winds north of the equator always blow counterclockwise. South of the equator they always blow clockwise. Tornado winds are not quite as predictable as hurricane winds. Most tornadoes in the United States blow counterclockwise, but one in twenty blows clockwise. No one is quite sure why this is so.

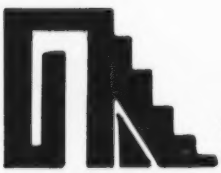
1. Flags flutter in the breeze instead of standing out straight because
   a. hurricane winds blow counterclockwise north of the equator.
   b. air currents blowing past it pull it from side to side.
   c. they wouldn't look right if they stood out straight.

2. If you lived in Australia, which is south of the equator, the bathtub twister would
   a. usually turn clockwise.
   b. usually turn counterclockwise.
   c. be unpredictable.

3. You can tell from the article that
   a. winds blow in different patterns north and south of the equator.
   b. waves travel in different directions north and south of the equator.
   c. there are more hurricanes and typhoons north of the equator than south of it.

Name _____

WIND AND WATER IN EARLY ART

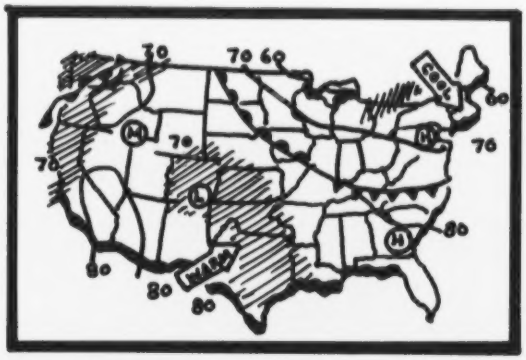


People all over the world have used spirals and sigmoids to represent the wind and the water. They have decorated walls, vases, coins, cloth, dishes, jewelry, tools, musical instruments, shields, weapons, and figurines with these spirals and sigmoids. Pictures of some of them are at the top and bottom of the page.

Below are outlines of some objects that need your decorations on them. Make them beautiful using spirals and sigmoids. You may copy from the spirals on the left and the sigmoids on the right, or you may invent your own spiral and sigmoid patterns.

LESSON 5 Name _____

LOW, LOW PRESSURE



Look at a weather map. Where it is marked "H" or "HIGH," the air pressure may be almost 31 units. The weather will probably be sunny and pleasant. Where the map is marked "L" or "LOW," the air pressure may be almost down to 29 units. The weather will probably be stormy.

In the eye of a hurricane, the pressure is much lower than the pressure in an ordinary storm—about 27 units. This is so low that the level of the ocean rises about two feet in the eye. Since the average diameter of the eye of a hurricane is 14 miles, the dome of water raised in the eye weighs about 450 billion tons.

In the funnel of a tornado, the pressure is much lower yet. The pressure has never been measured, because violent winds hurl objects which destroy instruments. But scientists looking at what tornadoes do have decided that in the worst tornadoes the pressure must be about 10 units. This very low pressure is what causes some of the freakish things tornadoes do, such as bursting tires and sucking wells dry.

What makes the pressure so low in hurricanes and tornadoes?

Maybe you have swung a weight around your head on a string. The faster you swung it, the harder the weight seemed to pull out. The air in a hurricane's eye and a tornado's funnel is whirling around at 75 to 300 miles an hour. The faster the air molecules swing around, the harder they pull away, and the fewer air molecules are left in the center. Less air means more air pressure.

1. Ocean water in the eye of a hurricane rises about two feet because
   a. of the low pressure in the eye.
   b. hurricane winds pile it up ahead of them.
   c. hurricanes make high tides.

2. When winds blowing around the eye of a hurricane get faster,
   a. the pressure in the eye will get higher.
   b. the pressure in the eye will get lower.
   c. the pressure in the eye will stay the same.

3. You can tell from the article that where air pressure is low
   a. the weather is probably fine.
   b. the weather is probably stormy.
   c. the weather will change soon.

Name _____

LOW PRESSURE AND TORNADO FREAKS

Tornadoes do many strange things. Winds blowing at 200 to 300 miles per hour have driven straws through wooden beams and wooden beams through iron posts. Winds blowing up have supported things falling down so that they fell slowly. Eggs have landed uncracked and mirrors have landed unbroken. One family reported that a tornado picked up their lighted kerosene lamp and set it down 400 feet away, still upright and still burning.

What might happen to these things inside a tornado funnel because of the very low air pressure? Remember that tornadoes have burst automobile tires and sucked wells dry.

1. Bicycle tires _____
2. Rubber rafts _____
3. Waterproof watches _____
4. Corked bottles—empty _____
5. Corked bottles—full _____
6. Freezers _____
7. Safes _____
8. Your ears _____
9. A house with doors and windows tightly closed (if the wind didn't blow it away first)

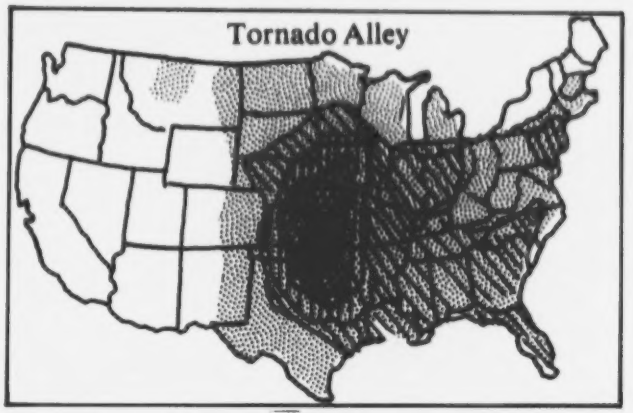
   _____
10. A house with doors and windows left open (if the wind didn't blow it away first)

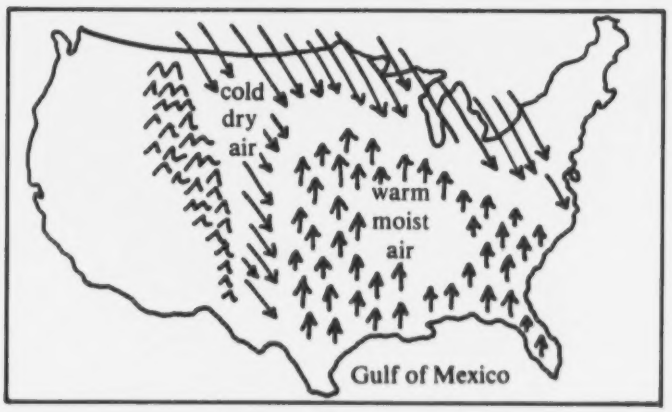
    _____

LESSON 6 Name _____

TORNADO ALLEY

Tornadoes happen all over the world. Most tornadoes, however, appear in the United States east of the Rocky Mountains. Look at the map on the right. The largest number of tornadoes occur in the darkest areas. This part of the world has been called "Tornado Alley." Many homes in Tornado Alley have underground shelters, and some schools are built partly underground for safety.





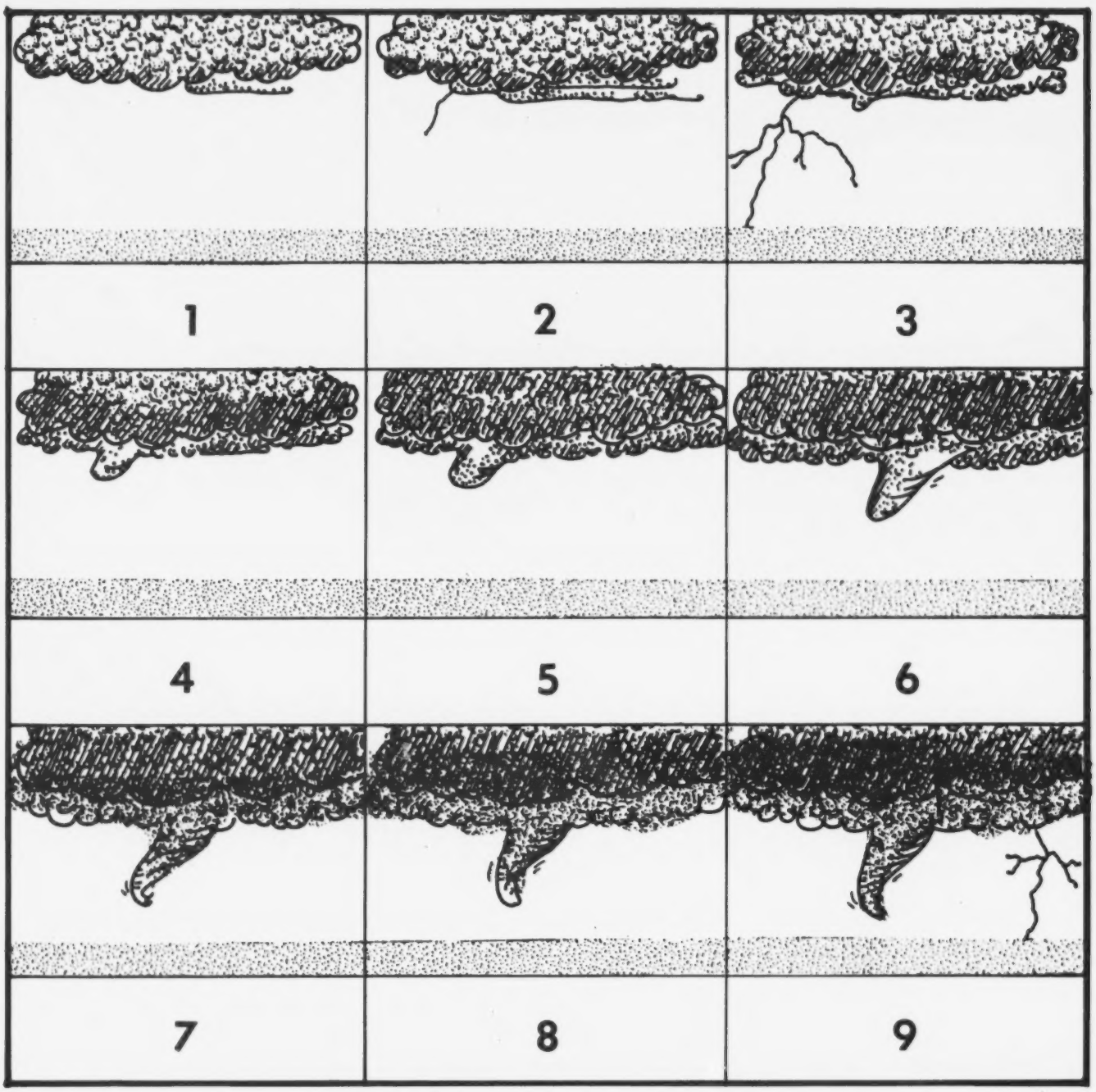
Why do so many tornadoes occur here? Scientists think it is because cool, dry air comes from deserts and mountains and meets warm, moist air coming north from the Gulf of Mexico. Many thunderstorms form when cool, dry air meets warm, moist air. Tornadoes start with violent thunderstorms. The two air masses pushing against each other may start the air under a thunderstorm twisting. To see how this works, put your pencil point down on your desk. Hold it between the palms of your hands. Push your right hand forward; this is like air moving north from the Gulf of Mexico. Your left hand is like air pushing southeast from deserts and mountains. The pencil turns counterclockwise like most tornadoes.

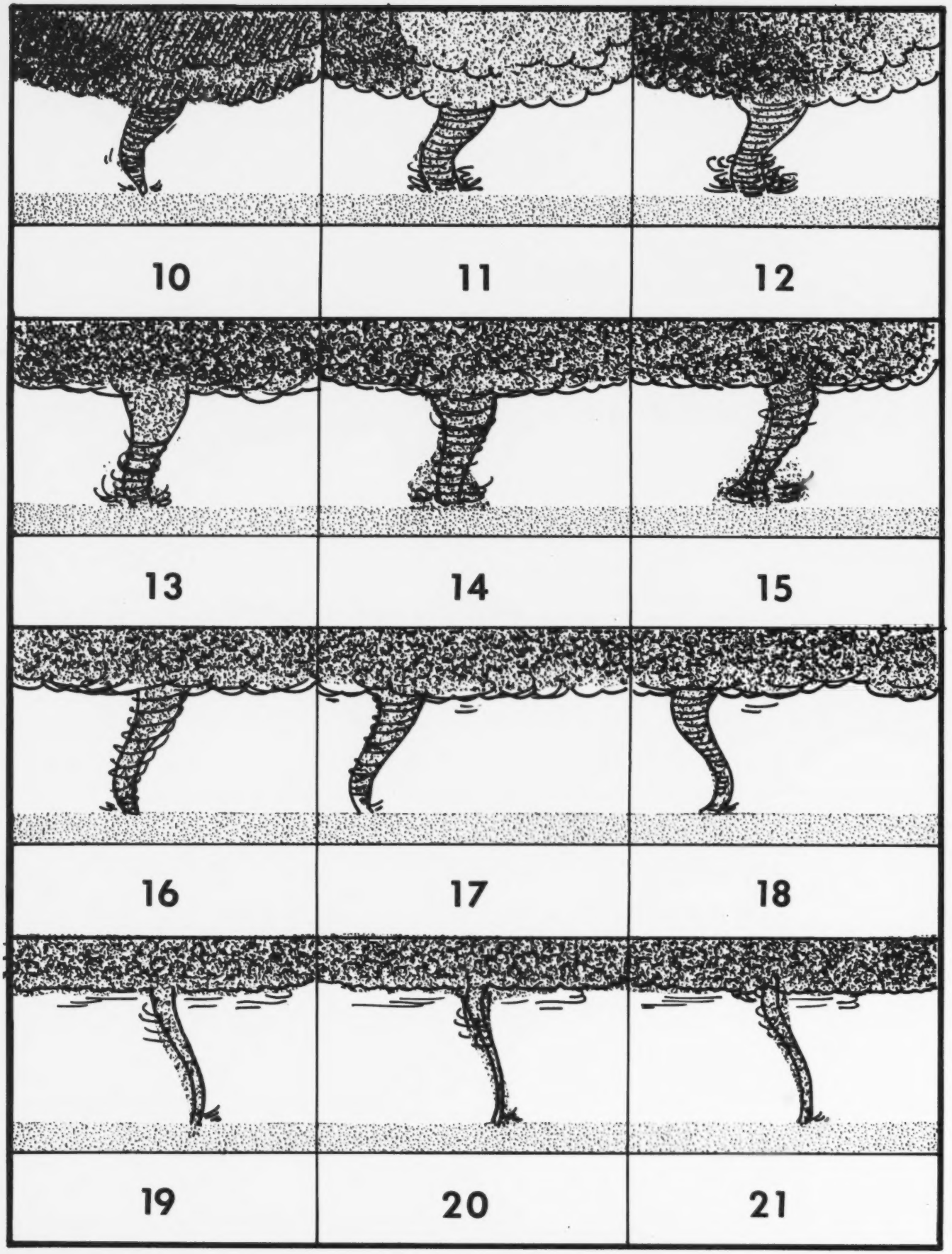
1. More schools are built underground in Kansas than in California because
   a. the weather is more pleasant in California.
   b. California has more earthquakes than Kansas, and it's not safe to be underground in an earthquake.
   c. Kansas has more tornadoes than California.
2. Where there are many tornadoes, a home buyer will probably
   a. plant trees all around the house to protect it from strong winds.
   b. look for a house with a tornado shelter or a basement.
   c. insulate his house very well.
3. From the article you can tell that
   a. there are more tornadoes in the mountains.
   b. tornadoes are more likely to happen in places where there are many thunderstorms.
   c. thunderstorms always cause tornadoes.

WATCH A TORNADO FORM

With this flip book you can watch a funnel form underneath a thunderstorm, reach down to the ground, pull up an envelope of dust around itself, then lose power and start to disappear into the whirling clouds above.

To make the flip book, cut along the solid lines. Put the pictures in order with number 1 on top of the stack and number 33 on the bottom. Hold the stack of pictures in one hand and flip through them with the other to see the tornado.

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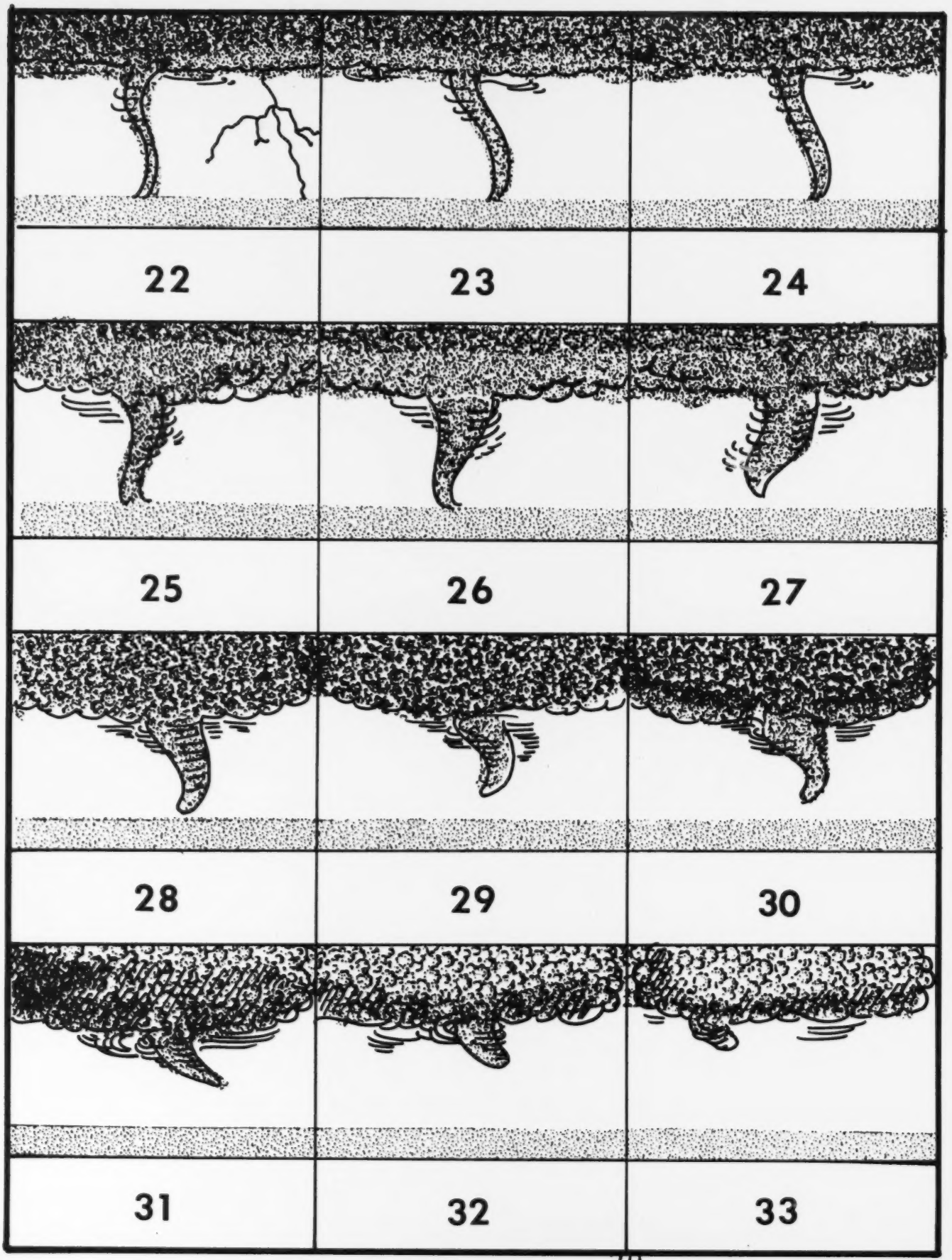

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LESSON 7 Name _____

HIGH, HIGH WINDS

Early explorers and missionaries who came to the Caribbean area were mostly Spaniards. There were no hurricanes in Spain. Spaniards probably did not believe the natives who told them about great storms that blew from one direction for hours with winds and rain so violent that even the strongest man could not stand up, then blew just as hard from the opposite direction, and sent enormous waves that destroyed whatever the wind and rain left. Perhaps they thought the natives were trying to scare them.

The Spaniards built towns right at the edge of the water because loading ships was easy there. Sometimes when the Spaniards returned from Spain, the towns had been blown and washed away by a hurricane. One Spanish priest called hurricanes "judgements of God" because of the cruel way the Spanish treated the natives. The natives could have told him that hurricanes had been killing people, uprooting trees, and destroying buildings long before the white man came.

What is it like to be in strong winds? With winds at gale force (over 39 miles per hour) it is hard to walk. With winds at hurricane force (75 miles per hour) even a strong man will be blown backwards. With winds at 150 miles per hour, a speed that has been measured in many hurricanes, a grown man lying down will be blown along the ground.

A tropical storm may have gale force winds over a circle of 200 miles or so. In a hurricane, the energy is concentrated into a much smaller circle; winds have hurricane force in a circle thirty or so miles across. In a tornado the circle of winds is smaller still, and the speed of winds is even greater.

1. There are hurricanes in the Caribbean because
   a. the Spaniards mistreated the natives.
   b. the air and ocean conditions are right for hurricanes.
   c. there are no hurricanes in Spain.

2. When explorers returned to Spain from the Caribbean and told about the hurricanes in the New World, most people probably
   a. thought they were making it up.
   b. blamed the natives for the storms.
   c. went to see for themselves.

3. If you hear that a hurricane is coming, a wise thing would be
   a. to hide under the bed.
   b. to pick up lawn furniture and other loose things in the yard.
   c. to call up your friend and talk it over.

Name _____

A TOOTHPICK AND NERDLE DOLL

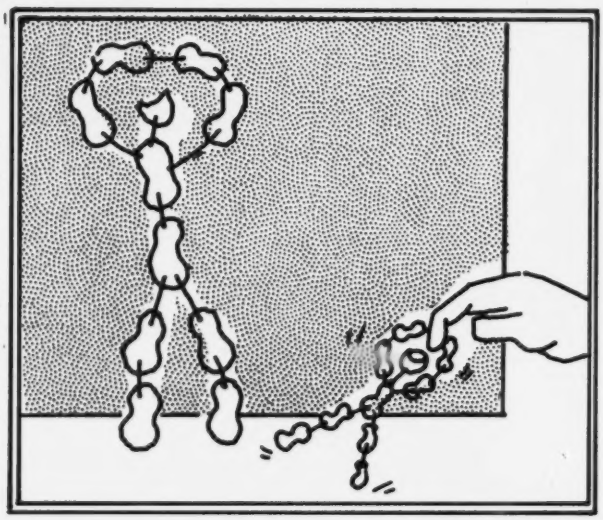
You can blow hard enough to turn a pinwheel, inflate a balloon, or make a policeman's whistle sound very loud. To a toothpick and nerdle doll, this is like a hurricane-force wind.

If your nerdles are of the peanut-shaped kind, you can make a small doll like the one in the picture with 10 toothpicks and 10 nerdles. You may want to design your own doll even with this kind of nerdle; with other shapes, you will have to be creative.

Can you blow your doll across your smooth desk? _____.

Can you blow it across a rug or rough piece of cloth such as your sweater? _____.

Perhaps you can fasten the doll's arms together with another piece of toothpick. Then you can put your finger on the desk and see if the doll can keep from being blown away by hanging onto your finger, as a person might hang onto a tree.



The worst danger from the wind is not that it will blow you away. The worst danger is that it will blow rocks and debris into you, or that it will blow trees or buildings down on top of you. Even if you are inside a strong building, you might be hit by flying glass.

What are the places in your house and school that would be safest in a hurricane? Try to think of places that are least likely to collapse. Remember that a small room is safer than a large one, and that windows are dangerous. Write these safest places below. If you live in a mobile home, write a place in a nearby stronger building where you could go.

In my home, places safest from the wind are: _____

_____

In my school, places safest from the wind are: _____

_____

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LESSON 8 Name _____

NAMING HURRICANES

Why do hurricanes have girls' names?

Sometimes tropical storms are blowing in several parts of the ocean at the same time. So that people will know which storm they are talking about, meteorologists (weather scientists) give each storm its own special name as soon as its wind speed reaches 40 miles per hour. For many years the meteorologists used only girls' names. Now they have six alphabetical lists of alternating girls' and boys' names. At the end of six years they start using again the names from the first list. In 1990, for instance, the first tropical storm in the Atlantic Ocean will be named Tropical Storm Arthur and the second will be named Tropical Storm Bertha. These were also the names of the first two Atlantic storms of 1984.

If wind speeds reach 75 miles per hour, the tropical storm is then called a hurricane; but it keeps the same name all its life whether it lasts two days or a month. Tropical Storm Arthur will be called Hurricane Arthur. It will become Tropical Storm Arthur again when its winds weaken to 74 miles per hour.

Tropical storms in the Pacific are given names from a different six-year list. Both lists can be changed if there is a good reason to do so. For instance, if a hurricane or typhoon kills so many people that it will be remembered for a long time and mentioned in history books, its name is replaced on the list and no more storms are given that name.

1. In 1954 Hurricane Hazel killed over 600 people and destroyed more than a billion dollars' worth of property. Hazel will
   a. be on the list of names for hurricanes every six years to honor the victims of the first Hazel.
   b. not again be used to name a hurricane because it was such a bad storm that it will go down in history.
   c. be used on typhoon lists but never again on hurricane lists because people in the Pacific were not hurt by Hazel.

2. If a tropical storm is named Isaac, the next storm might be named
   a. Josephine.
   b. John.
   c. Hilda.

3. You can tell from the article that
   a. names of storms are changed when wind speeds reach 75 m.p.h.
   b. the Weather Bureau chooses names for hurricanes.
   c. some hurricanes do much more damage than others.

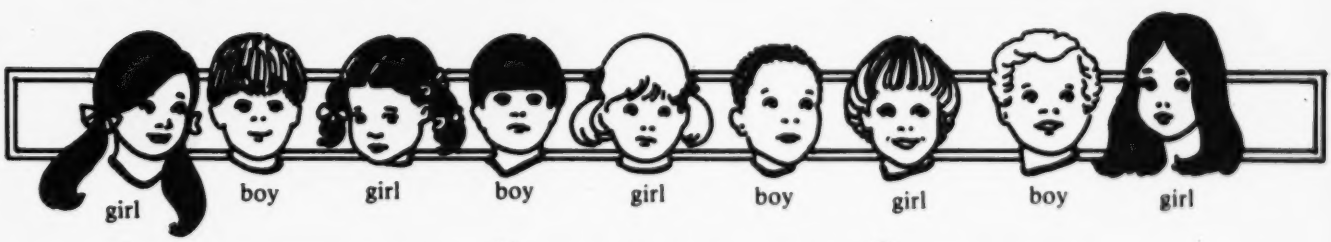
Name _____

1987 HURRICANE NAMES

Find the 21 names reserved for the 1987 hurricanes in the word search. Names can go forward, down, or diagonally from left to right.

Some of the names are rarely used in the United States because the list is chosen by an international group of meteorologists (weather scientists). No names are chosen for Q, U, X, Y, or Z because of the scarcity of names beginning with those letters.

K	O	N	L	B	K	L	J	D	F	W	E	C	A
E	A	A	A	R	L	E	N	E	C	I	N	D	Y
M	O	T	I	E	S	N	A	N	F	L	O	Y	D
I	G	E	R	T	T	N	V	N	G	M	H	D	B
L	E	P	E	I	A	Y	R	I	T	A	A	I	H
Y	Q	S	N	R	N	M	J	S	N	T	R	M	V
O	P	H	E	L	I	A	M	O	N	C	V	U	A
B	M	A	R	I	A	W	E	Y	S	F	E	R	M
E	P	H	I	L	I	P	P	E	U	E	Y	I	O



A _____ H _____ O _____

B _____ I _____ P _____

C _____ J _____ R _____

D _____ K _____ S _____

E _____ L _____ T _____

F _____ M _____ V _____

G _____ N _____ W _____

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LESSON 9 Name _____

HURRICANE HUNTERS

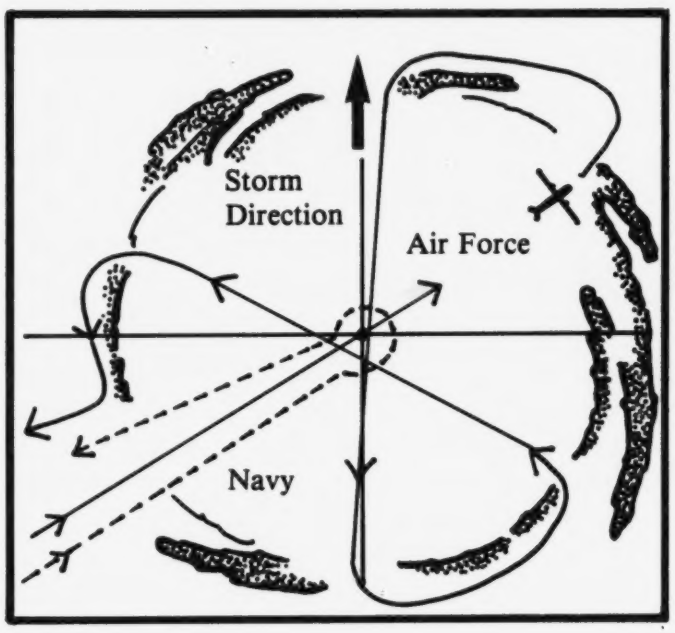
People have been trying to explain and control hurricanes since the dawn of man. Until the invention of the airplane, however, no one could observe them except at ground level. Even then, most people thought that flying into a hurricane would be certain death. In 1943, however, two Air Force pilots heard that a hurricane was nearby and decided to try it. They lived; they returned to their base; and then they flew again into the same hurricane—this time with a weather officer aboard.

Now the Weather Bureau sends planes into tropical storms every six hours to take measurements. The crews of these planes are called "Hurricane Hunters."

Hurricane Hunters in Navy planes fly in under the clouds, circle the eye twice, then fly out along the same path.

Hurricane Hunters in Air Force planes fly completely through the storm several times at about 10,000 feet, making a clover-leaf pattern.

Hurricane Hunters have a rough ride. Instruments must be bolted down to keep them from being tossed about the cabin when the plane is jerked around by violent updrafts, downdrafts, and heavy winds, rain, and hail. In spite of the dangers, no Hurricane Hunter plane has ever been lost.



Information collected by Hurricane Hunters has saved many lives. Predictions about when and where storms will hit are now much better than they used to be, thanks to the Hurricane Hunters.

1. People know more about hurricanes than they did long ago because
   a. people are smarter than they used to be.
   b. more people observe them nowadays.
   c. people can now observe hurricanes from planes.

2. When we know more about hurricanes, we will
   a. stop building cities where hurricanes may strike.
   b. be better able to predict exactly where they will strike.
   c. stop sending Hurricane Hunters into dangerous storms.

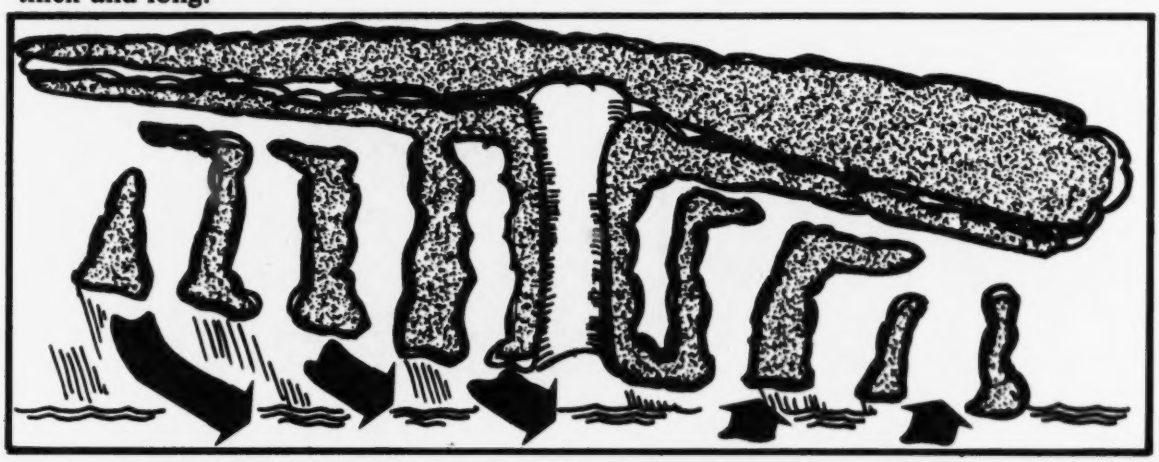
3. You can tell from this article that
   a. the Air Force has better planes than the Navy.
   b. all tropical storms turn into hurricanes.
   c. the Weather Bureau thinks that information collected by Hurricane Hunters is very important.

Name _____

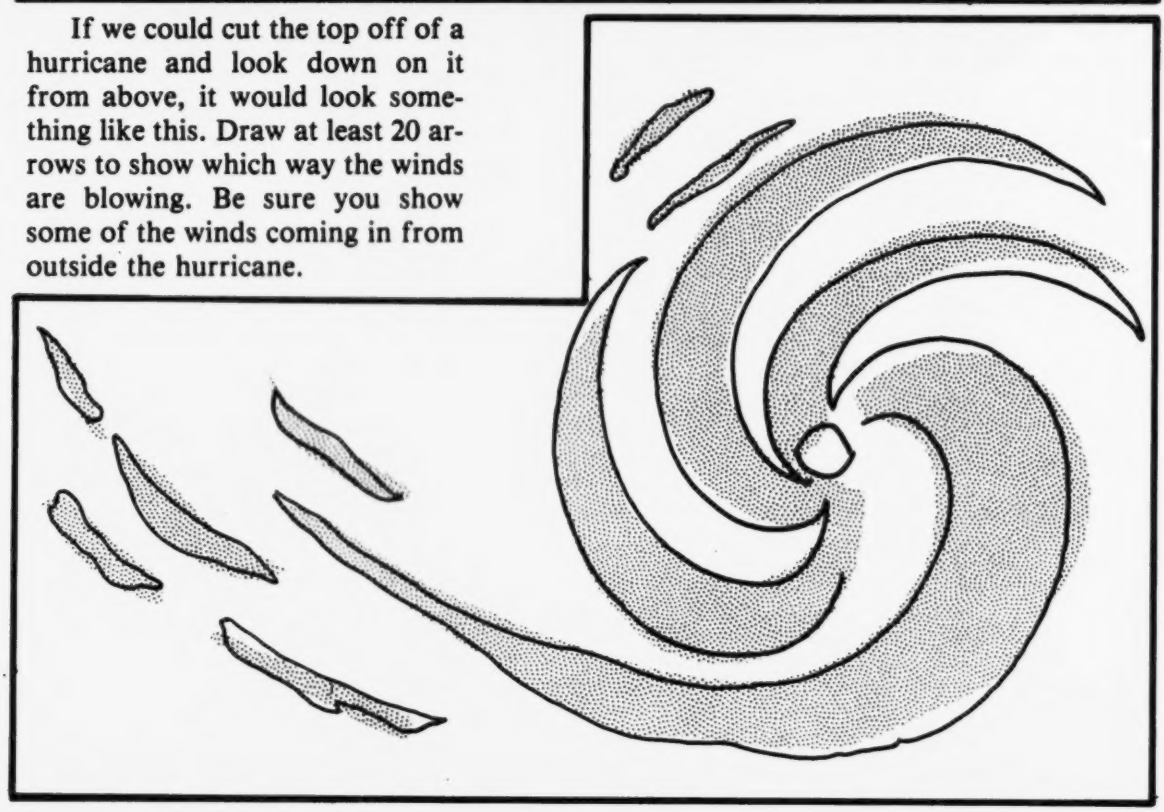
WHAT'S INSIDE A HURRICANE?

Hurricane Hunters have learned what goes on in the part of a hurricane that we can't see from the ground because of the wind and rain and a satellite can't see from space because of the clouds.

If we could slice through a hurricane from side to side, it would look something like the diagram below. The arrows already there show winds at the surface. Add arrows showing the updrafts and downdrafts. Air in the cloud walls is moving up. Air in the clear spaces between the cloud walls is moving down. Air in the eye is moving down, too, but very gently. Make your arrows in the eye small and in the cloud walls big. The strongest updrafts are in the wall of clouds right around the eye. Make your arrows there thick and long.



If we could cut the top off of a hurricane and look down on it from above, it would look something like this. Draw at least 20 arrows to show which way the winds are blowing. Be sure you show some of the winds coming in from outside the hurricane.



LESSON 10 Name _____

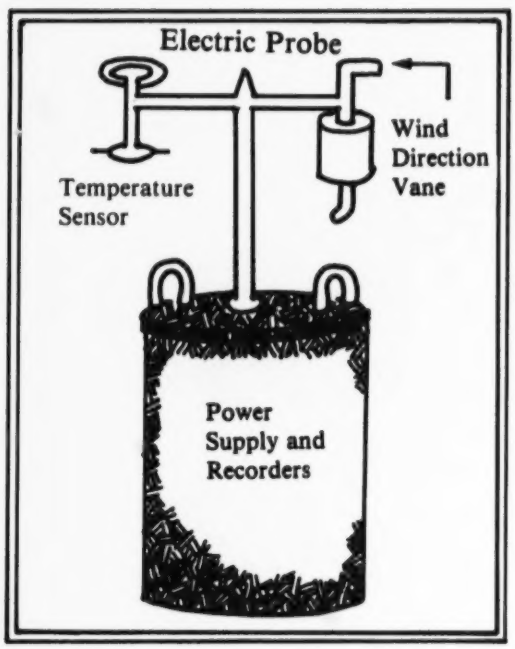
TORNADO CHASERS

Tornado chasers can't fly through tornadoes as Hurricane Hunters fly through hurricanes. Objects hurled about by a tornado's 200-mile-per-hour winds would smash any plane. Also, tornadoes last only a few minutes, usually about 20, which doesn't give the crew time to get to the plane and take off.

Our word TORNADO comes from a Latin word meaning thunder. Tornadoes form in violent thunderstorms. Where such thunderstorms are likely, weather scientists alert a two-man crew or tornado chasers to get ready for action.

Tornado chasers use a small, super-strong, barrel-shaped weather station. When a tornado is seen, the two men drive in a pickup to a place northeast of the funnel because most tornadoes travel northeast. They roll the little observatory to the ground on a ramp, set it up quickly, and drive to safety while instruments in the little observatory record wind speed, air pressure, temperature, and electric jolts.

The name of this kind of weather observatory is TOTO. This name is partly for TOtable TOrnado observatory and partly for Toto, the little dog who traveled in a tornado with Dorothy in the story *The Wizard of Oz*.



1. Tornado chasers don't use airplanes because
   a. tornadoes are hard to find from the air.
   b. planes can't fly in thunderstorms.
   c. no planes are strong enough for a tornado's battering.

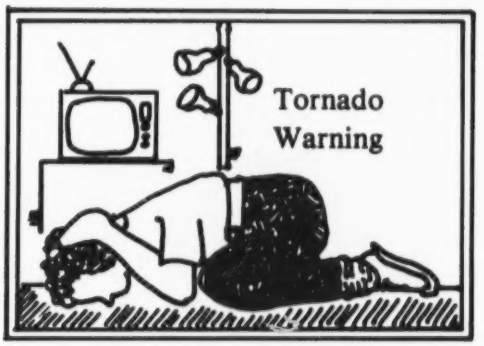
2. If a tornado funnel picks up a TOTO, information it gathers will probably
   a. be destroyed.
   b. be valuable.
   c. be useless.

3. You can tell from the article that
   a. tornadoes usually travel in the same direction after they touch down.
   b. tornadoes destroy more property than hurricanes.
   c. tornadoes last longer than hurricanes.

Name _____

MY TORNADO ACTION PLAN

Since a tornado can happen in any state, at any time of day or night, and in any month of the year, we all need to know what to do in case of a tornado.



The NOAA issues a TORNADO WATCH if the weather is the kind that makes tornadoes likely. During a Tornado Watch you should listen to a local radio or TV station and watch the weather carefully. The NOAA issues a TORNADO WARNING if a tornado has been sighted; but tornadoes are so sudden and so short-lived that you have only a few seconds to act. There is no time to leave the area or to find your family.

Be sure that you and your family know what to do if you are at home when a tornado is sighted. Use this decision-making key to help you decide on a plan.

A. Do I live in a mobile home?
   - ☐ Yes: go to F.
   - ☐ No: go to B.

B. Does any building have a storm shelter or a strong basement?
   - ☐ Yes: go there quickly in case of a tornado warning.
   - ☐ No: go to C.

C. Is there a small room (closet, bathroom) without windows or outside doors near the center of my building?
   - ☐ Yes: go there quickly. Curl up on the floor, and protect your head as in the picture.
   - ☐ No: go to D.

D. Is there an inside wall with sturdy furniture near it (bed, sofa) that I can crawl behind or under?
   - ☐ Yes: get under the furniture or between it and the wall.
   - ☐ No: go to E.

E. Find an inside wall or doorway. Curl up on the floor, facing the wall. Cover your head. Stay there till the violence is over.

F. Is there a nearby strong building you can go to?
   - ☐ Yes: go to B.
   - ☐ No: go to G.

G. Find the nearest ditch, ravine, or culvert. Lie in it face down, and cover your head with your hands. Stay until the violence is over.

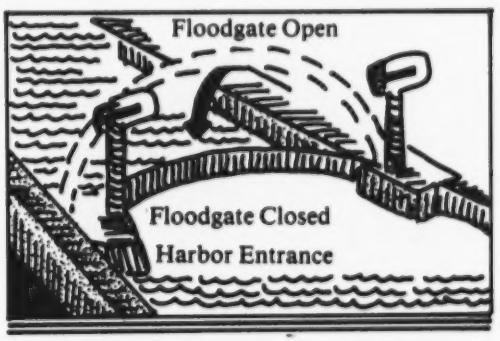
LESSON 11 Name _____

DEFENDING OURSELVES AGAINST HURRICANES

Most of the damage from hurricanes comes not from the wind and rain but from the towering waves and floods they bring. A town on the coast is flooded from two sides. Torrential rains fill rivers which come rushing toward the coast. At the same time the storm surge can bring waves as high as a several-story building. Typhoons in the Pacific Ocean can be even worse than hurricanes in the Atlantic. Since the Pacific Ocean is bigger, the storms it generates often have more time to grow before they hit land. Storm surges from typhoons in the Bay of Bengal have twice killed 300,000 people.

The two ways to defend against hurricane injury are to move the people out of the way of the floods or to keep the storm surge out. In the U.S.A. we use the first way. The National Weather Service tries to give twenty-four hours' notice that a hurricane will strike. Sometimes this is not enough time, particularly when cities have been built on offshore islands from which everybody must move to the mainland over a single bridge.

The city of Osaka in Japan uses the second way. Floodgates keep the storm surge out of the city, and giant pumps drain off rainwater coming down the rivers. The gates are open most of the time to let ships through. The gates close and the pumps start only when a typhoon threatens.



Hurricanes destroy more property now than ever before because people build bigger and bigger cities in hurricane country. At the same time, hurricanes kill fewer people than ever before because our hurricane predictions and warning systems are improving all the time.

1. Hurricanes destroy more property than they used to because
   a. hurricanes are worse than they used to be.
   b. people keep building in hurricane areas.
   c. buildings aren't as strong as they used to be.

2. When a hurricane goes over land,
   a. flooding of inland cities will usually be worse than flooding of coastal cities.
   b. flooding of coastal cities will usually be worse than flooding of inland cities.
   c. flooding will probably be equally bad in both inland and coastal cities.

3. From the article, you can tell that
   a. typhoons are a frequent problem in Japan.
   b. Japanese scientists spend more time studying storms than American scientists.
   c. Osaka has many rivers running through it.

Name _____

MY HURRICANE ACTION PLAN

NOAA (the National Oceanic and Atmospheric Administration) issues a HURRICANE WATCH for an area if a hurricane is possible there within 24 to 36 hours. NOAA issues a HURRICANE WARNING if a hurricane will probably hit the area in less than 24 hours. In a WATCH, be sure you know what to do in case of a WARNING. In a WARNING, do it.

If you live in hurricane country, read the plan below, check the boxes that fit your case, and fill in the blanks that apply to you.

If you do not live in hurricane country, pretend that you live in Key West, Florida, and fill out the plan accordingly. Use a map of Florida to help you plan. You need to know that Key West is five feet above sea level.

A. Is my home at least 25 feet above sea level? ☐ Yes: go to B.
☐ No: go to D.

B. Do I live in a mobile home? ☐ Yes: go to D.
☐ No: go to C.

C. Do I live near a river or on a floodplain? ☐ Yes: go to D.
☐ No: go to E.

D. I must plan to leave if NOAA issues a hurricane warning. I need to decide with my family where to go and what to take.

We will go to _____.

We plan to take this food: _____.

We plan to take this clothing and bedding: _____

_____. We will also need to take these personal things (such as medication, books, games, baby formula):_____

_____.

We will need flashlight and battery radio, also. We need to let these relatives or friends know where we will be: _____

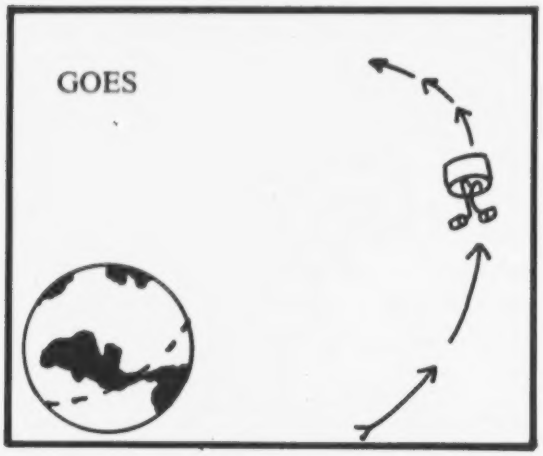
E. We may be able to stay at home. We need to prepare for the wind and rain by shuttering, boarding, or taping windows and by taking lawn furniture and taking anything loose such as potted plants indoors so they won't become wind-blown hazards. We need to lay in supplies of fresh water, canned and dried food, batteries for flashlight and radio, and perhaps pet food.

LESSON 12 Name _____

WEATHER SATELLITES: SPIES IN THE SKIES

Two TIROS-N weather satellites circle the earth fourteen times a day around the North and South Poles, taking pictures from 530 miles above the surface. Because the earth is turning beneath them, the pictures show a different strip of the earth on each trip.

Computers put the strips together to make a picture of the earth as you would see it looking down from high above one of the poles.



Four GOES satellites seem to sit 22,300 miles up in space over four spots on the equator. They are really orbiting at almost 7000 miles per hour, exactly fast enough to keep them over the same spot on the earth. Moving cameras take pictures of 5-mile circular strips of the earth, filling in the circle in about 18 minutes. Computers put the circular strips together to make pictures of the earth as you would see it looking down from high above the equator.

On the daylight side of the earth, weather satellites take pictures using light rays. On the night side they take pictures using heat rays. Thus we can spy on developing storms twenty-four hours a day. We can always see where storms are; Hurricane Hunters know just where to fly. We can see how strong storms are; the smaller the eye, the faster the winds are blowing. We can tell whether storms will get stronger or weaker; warm water ahead of them means they will get stronger, but land or cool water ahead means they will get weaker.

1. Satellite cameras take pictures with both heat rays and light rays
   a. so that we can see what's happening on both sides of the earth.
   b. to see which kind of ray gives better pictures.
   c. in case one kind of camera breaks down.

2. If a hurricane reaches the coast of Georgia and travels inland over Tennessee and Kentucky, the strongest wind will be
   a. over Georgia.
   b. over Tennessee.
   c. over Kentucky.

3. You can tell from the article that
   a. hurricanes start over the ocean.
   b. heat and moisture are important to hurricanes.
   c. heat-ray pictures give more useful information than light-ray pictures.

Name _____

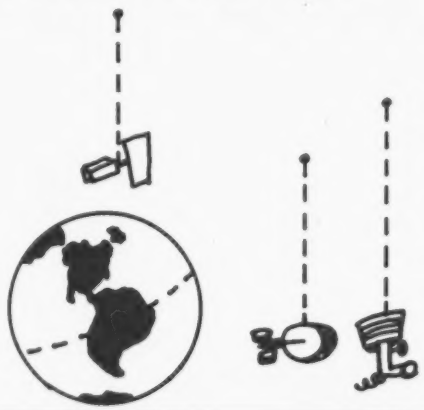
PUT WEATHER SATELLITES AROUND YOUR CLASSROOM GLOBE

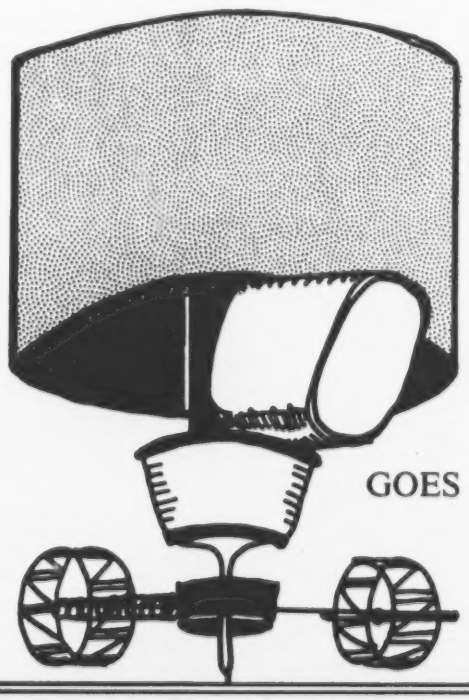
Your classroom globe is about ten inches in diameter. It represents the earth, which is 8000 miles in diameter. TIROS-N satellites orbit 530 miles up, 96 times as high as Mt. Everest. GOES satellites orbit 22,300 miles up, 4060 times as high as Mt. Everest.

This means that on your ten-inch classroom globe TIROS-N should be about eleven sixteenths of an inch from the surface. GOES should be about twenty-eight inches from the surface.

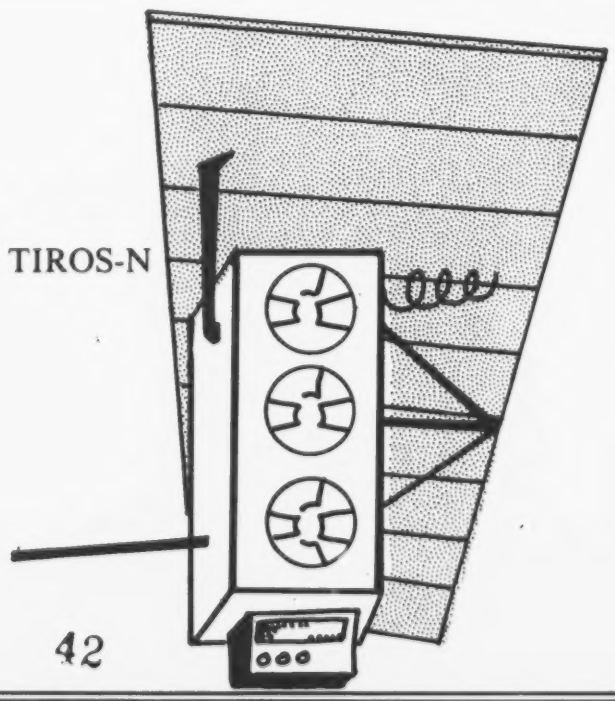
Using these pictures of TIROS and GOES, make small models to suspend from the ceiling at the correct distances from your globe. Hang GOES so that it is directly over some spot on the equator. You could put TIROS-N over any spot on the globe, but you may want to put it over a pole to remind you that it travels a polar orbit.

To be in scale, your models would have to be much smaller than the head of a pin because the satellites are only a few feet across. Since you can't do this, you may want to make them whatever size is easiest. Hang a picture of a magnifying glass near them to show that the satellites are out of scale even though their positions are correct.





GOES



TIROS-N

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LESSON 13 Name _____

WHAT ABOUT COLUMBUS?

Christopher Columbus was lucky in 1492. He sailed in the middle of the hurricane season into the part of the Atlantic Ocean where hurricanes are fiercest and then sailed back to Spain again without seeing a hurricane. We know that a hurricane was blowing somewhere in the Atlantic during his voyage because the ship's log tells of huge sea swells that tossed the ships about even though there was no wind. A hurricane raises sea swells which travel hundreds of miles across the ocean, far from the hurricane itself. Such swells from a distant hurricane tossed Columbus' ships.

Why did Columbus set sail during the hurricane season? Didn't he know any better? No, he didn't. Hurricanes don't happen in Europe, so Columbus knew nothing about them.

Columbus was not so lucky on his later voyages. In 1503 a hurricane caught his ship. He described it in a letter:

> "For nine days I felt without hope of life. Eyes have never seen such towering waves, angry and covered with foam . . . like a pot on a hot fire . . . . For one whole day and night the sky blazed like a furnace, and each time the lightning broke forth I wondered if it had carried off my spars and sails . . . . All this time the water never stopped falling. I don't say it rained, because it was like another deluge. The people were so worn out that they longed for death to end their suffering."

1. A hurricane on one side of the ocean can cause
   a. sea swells on the other side of the ocean.
   b. thunderstorms on the other side of the ocean.
   c. tornadoes on the other side of the ocean.

2. After a sea captain had lived through a hurricane, he would probably
   a. keep it a secret.
   b. pay closer attention to weather warnings.
   c. set sail only when the moon was full.

3. From the story you can tell that the reason Europeans were not afraid of hurricanes is that
   a. they were braver than the Indians.
   b. their buildings were strong enough to stay standing in a hurricane.
   c. they didn't know about hurricanes.

Name _____

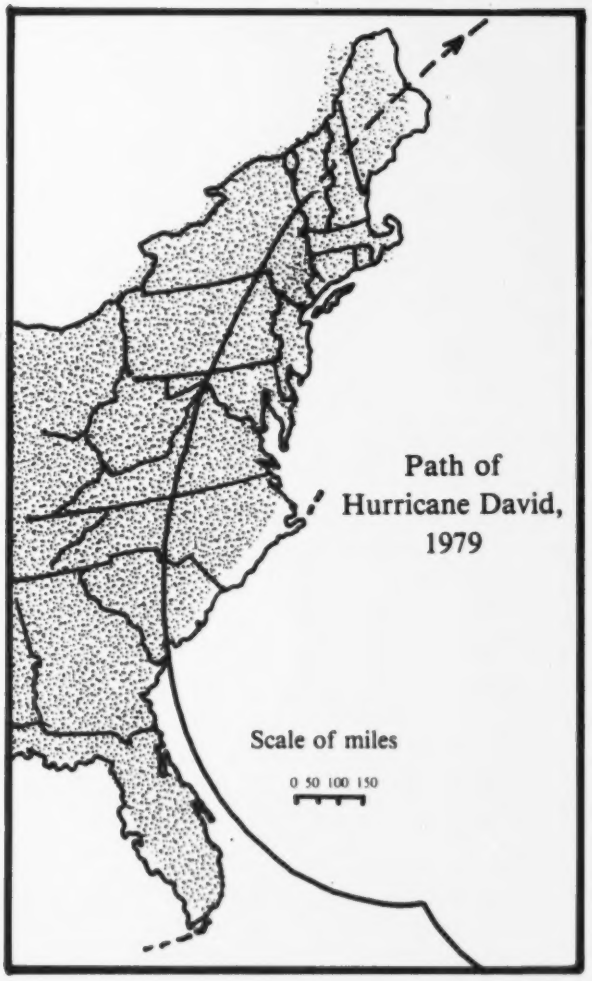
A HURRICANE'S PATH

How much damage does a hurricane do? It does not do much if it stays over the ocean. Ships are warned by radio and get out of the way. When a hurricane moves over land, it does a lot of damage over a wide area before it dies.

Some of the storm damage is due to wind. Some hurricane winds reach a speed of 150 miles per hour. Winds of that speed can pick up furniture, boards, signs, and toys and hurl them through windows and into people.

Some of the damage is due to rain which comes so fast that the rivers cannot carry it away unless they overflow their banks. Towns and farms are flooded.

The worst damage comes from what is called the storm surge. Hurricanes push huge waves ahead of them. If these waves arrive at high tide they can be as tall as a four-story building. Houses along the coast can be washed away.



Swollen rivers and storm surge can cause damage over wider areas than the storm's path. Your map work here will show only the area of damage due to hurricane winds.

The average hurricane has wind speeds greater than 74 miles per hour over a 100-mile diameter. That's 50 miles on each side of the eye.

This map shows the path traveled by the eye of Hurricane David of 1979. David had full hurricane force winds (over 74 miles per hour) where the line is solid. David weakened to a tropical storm when it reached Vermont; this part of its path is shown with dotted lines. Use the scale of miles to draw David's 100-mile-wide path on this map. Then find a map showing East Coast cities. If your social studies book does not have such a map, find one in an atlas. On another piece of paper, list the cities that had hurricane-strength winds because of David.

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LESSON 14 Name _____

TREASURE SHIPS

Columbus made several trips to the New World. In 1503 he was getting ready to sail home when he noticed that the sky was coppery-colored and streaked with filmy clouds. By 1503 he had learned quite a bit about hurricanes. He knew that a coppery sky with filmy clouds usually meant that a bad storm was on the way, so he decided to wait until after the storm to leave. He advised the commander of a fleet of twenty-four treasure ships to wait it out, too. The commander didn't listen to the warning. Two days later, twenty ships of his fleet were sunk by the hurricane, and three limped back to port; only one made it to Spain. Columbus then sailed safely home.

People who have studied shipping records estimate that about one fourth of all the gold ever mined lies at the bottom of the sea. Much of this gold is in hurricane-sunk ships that were carrying to Spain treasure stolen from the Indians. At least 150 such ships lie between Spain and the New World.

Pirates followed the wealth, and they rather easily captured lone ships. The Spaniards soon learned to sail in fleets for protection. However, when ships sank in shallow waters, pirates often found and looted them before salvage crews sent by the government could arrive. Much of the treasure which lies in deep water is still there, in the ships which hurricanes sank.

1. Many treasure ships sank because
   a. they were overloaded and too heavy.
   b. the treasure was stolen, and God sank the ships to punish the thieves.
   c. they ran into hurricanes.

2. After Spanish captains learned that most hurricanes happen in summer and fall, they probably
   a. tried to time their trips to avoid summer and fall.
   b. took a priest along.
   c. consulted an astrologer before sailing.

3. From this article you can tell that
   a. many people did not believe a hurricane was really dangerous until they had been in one.
   b. only cowards fear hurricanes.
   c. hurricanes kill more sailors at sea than people on land.

Name _____

WHO OWNS THE TREASURE?

Diving for sunken treasure can be an expensive adventure when the treasure is in deep waters. First the treasure hunter must search old records to find the likeliest places to look. Then he must outfit a ship, pay a crew, and buy deep-sea diving equipment. The search may take months or years of his life. He may never find enough treasure to pay his expenses.

Who should get the treasure? The person who finds it? The descendents of the Indians from whom it was stolen? The government of Mexico, the country from which it came? The government of Spain, whose ships were carrying the treasure when they sank?

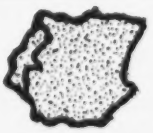
Divide the class into four groups, each with a simulation card. Each group will think of reasons why it should get the treasure, or why and how it should be divided. After five minutes of discussion, each group will choose a spokesperson to present that group's point of view to the class. Students may then discuss the options. If agreement seems unlikely, they may choose a panel to work out a recommendation. The class may vote to accept or reject the panel's suggestions.

The treasure hunter:

You have spent much time and money. If you had not done so, the treasure might never have been found. You feel you should get all the treasure, or at least a large share.

The Indians' descendents:

The treasure was stolen from your ancestors. Therefore, you feel that you should receive the entire treasure. The treasure hunter can get his money back by writing a book about it.



The government of Spain:

The ship holding the treasure is a Spanish ship. If that ship had not sailed, there would be no treasure to discover. The hurricane that sank it was an act of God, so the sinking was not your fault. You feel you should get all of the treasure after the hunter's expenses are paid.

The government of Mexico:

You represent the people from whom the treasure was stolen. You can take better care of it than the descendents themselves. The gold vases and statues should go into a museum, and you have a natural museum that would take care of them. You would pay the treasure hunter for his time and equip the ship for another trip to find more treasure.

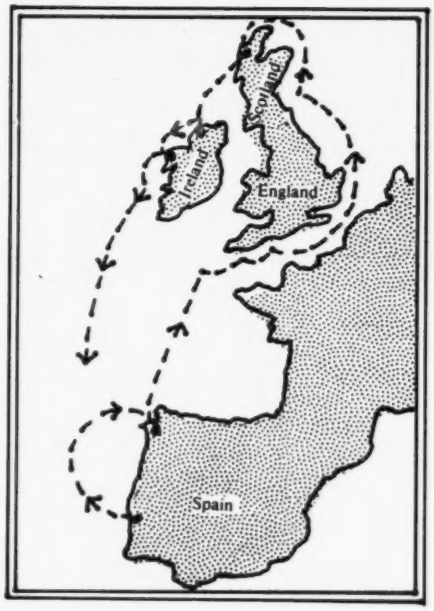
LESSON 15 Name _____

HURRICANES AND HISTORY: THE SPANISH ARMADA

Hurricanes have changed history many times. Two hurricanes in 1588 changed American history in a surprising way.

King Phillip II of Spain was very angry with the English. Spain already ruled most of South and Central America, but Phillip II wanted North America too, and the English navy kept getting in the way.

In 1588 King Phillip sent the Invincible Armada to conquer England. (An armada is a fleet of armed ships. Invincible means "can't be beaten.") To keep the trip secret, the Spanish fleet sailed west, to stay out of sight of land. This tactic put them right in the path of a hurricane which damaged many of the ships so badly that they had to return to Spain for repairs. While they were in port, the English learned about the Spanish plan. The English navy was waiting one month later when the Armada sailed into the English Channel. The English had fewer ships and men, but they held off the Spanish for ten days. Then another hurricane appeared. The English scurried to harbor, but the Spanish had no place to go for shelter. The winds badly damaged many of their ships. The rest tried to get back to Spain by going north around Scotland and Ireland. About half of them made it, but the rest were blown into reefs by the wind or sand in the open sea.



Queen Elizabeth I of England had a victory medal struck. It said, "God breathed, and they were scattered." The Armada might have been invincible to the English, but it was not invincible to hurricanes.

Phillip II had bankrupted Spain trying to conquer England. Now the North Atlantic was open to colonists from other countries. Without those two hurricanes, English colonists probably could not have settled at Jamestown and Plymouth, nor French colonists at Quebec and Montreal, nor Dutch colonists on Manhattan Island.

1. The English defeated the Spanish Armada because
   a. Englishmen are braver than Spaniards.
   b. English ships had better guns than the Spanish ships.
   c. bad weather hurt the Spanish more than it hurt the English.
2. Before setting out on a cruise or a fishing trip, a wise sailor
   a. checks the weather prediction.
   b. checks the phase of the moon.
   c. consults his horoscope.
3. From this article, you can tell that
   a. hurricanes can change history.
   b. hurricanes decide the outcomes of all battles.
   c. the English, French, and Dutch like hurricanes.

Name _____

WHAT IF SPANIARDS HAD NAMED THESE CITIES?

If hurricanes had not helped to defeat the Invincible Armada, early colonists on our East Coast would probably have been Spanish instead of English, French, and Dutch. They would have given their cities Spanish names. Perhaps the area would be known as Nueva Espana (New Spain) instead of New England. Perhaps instead of New York we would have Neuva Barcelona, and instead of New London, Neuva Valencia.

See if you can translate the Spanish city names below into the English names that they have now. The Spanish mini dictionary will help you.

Spanish Name	English Name
Aguaclara	_____
Campo del Fontana	_____
Cascade Internacional	_____
Ciudad Atlantica	_____
Ciudada Bahia	_____
Ciudad Lago Salado	_____
Curva del Sur	_____
Independencia	_____
Lago Carlos	_____
Pedernal	_____
Playa Palmera de Occidente	_____
	_____
Portatierra	_____
Providencia	_____
Roca Parva	_____
San Paulo	_____
Selvaverde	_____
Termas	_____

Spanish Mini Dictionary

Spanish	English
Atlantico, -ca	Atlantic
agua	water
bahia	bay
campo	field
Carlos	Charles
cascada	falls
ciudad	city
claro, -ra	clear
curva	bend
de	of
del	of the
fontana	spring
independencia	independence
internacional	international
lago	lake
occidente	west
palmera	palm tree
parvo, -va	little
Paulo	Paul
pedernal	flint
playa	beach
porta	port
providencia	providence
roca	rock
salado, -da	salty
san	saint
selva	wood
sur	south
termas	hot springs
tierra	land
verde	green

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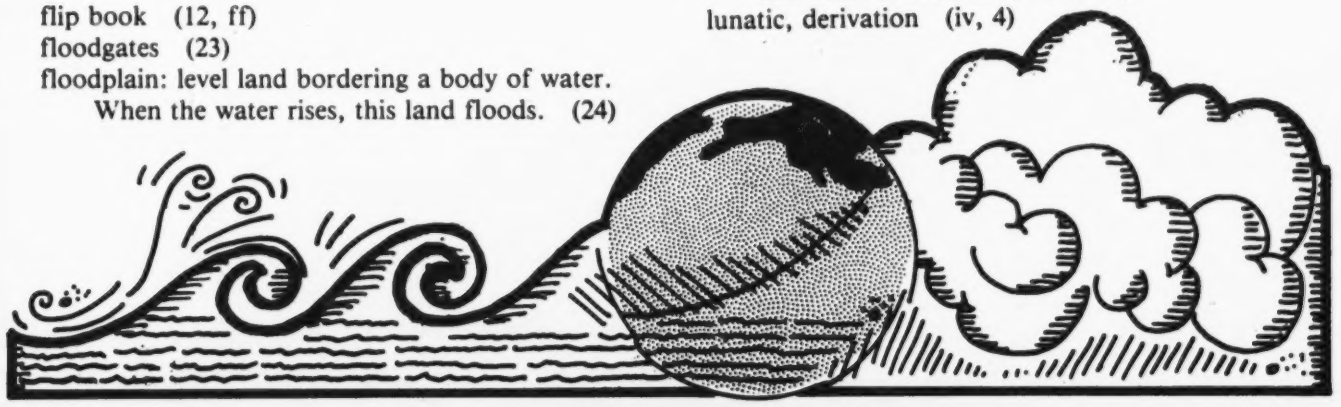

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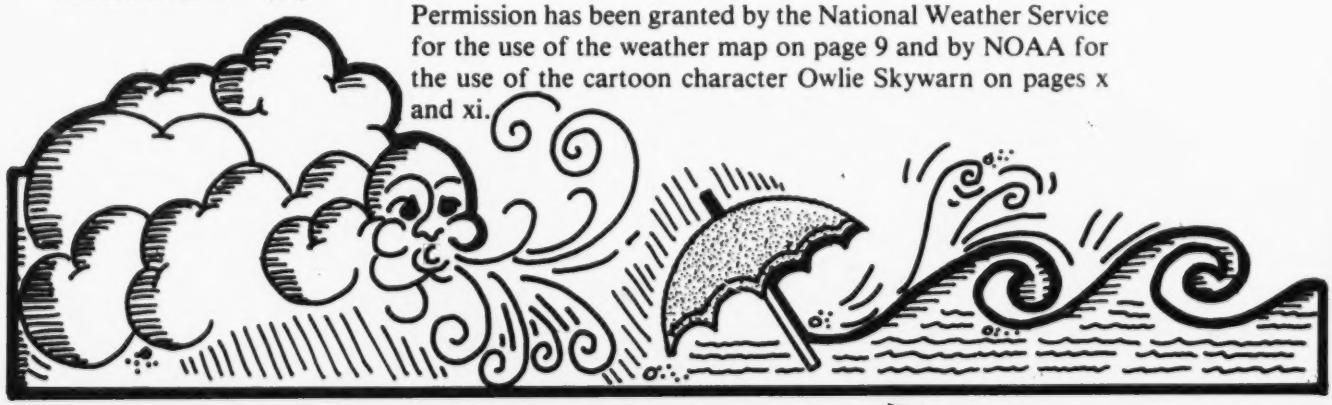

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